From Education → ***To Application***

Learning from the Past to Protect the Future: *Creating our Nation's Next Earthquake & Tsunami Survival Stories*

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National Tsunami Hazard Mitigation Program
NOAA
FEMA
USGS science for a changing world
Washington Military Department Emergency Management Division
WASHINGTON STATE DEPARTMENT OF Natural Resources
Peter Goldmark - Commissioner of Public Lands

Presentation Overview

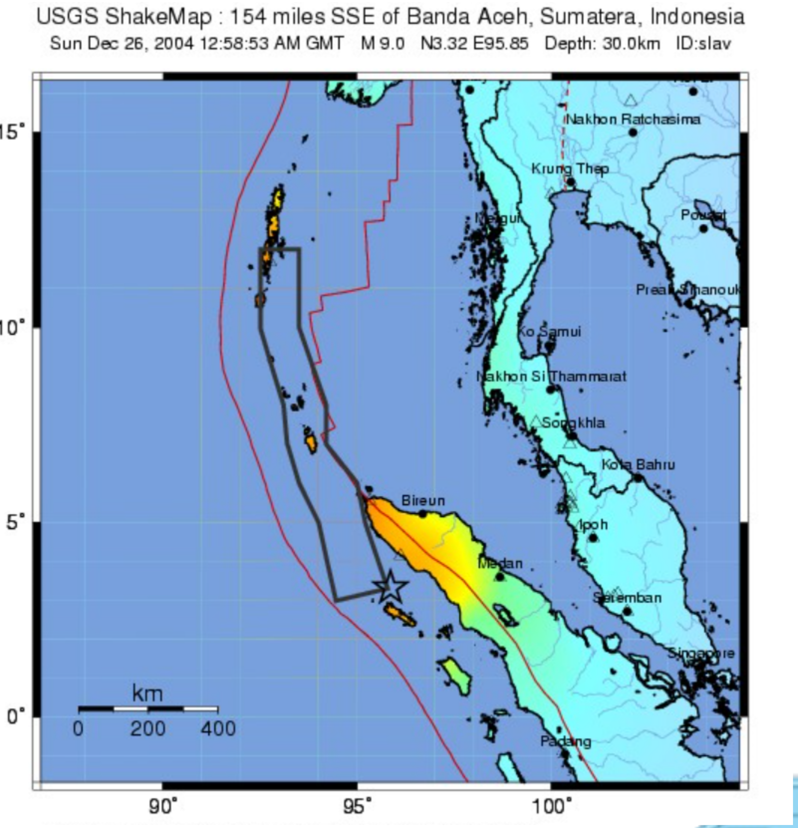
- This presentation will focus on how preparedness efforts have evolved and improved over the past decade since the devastating 2004 Indian Ocean Tsunami claimed more than 200,000 lives.

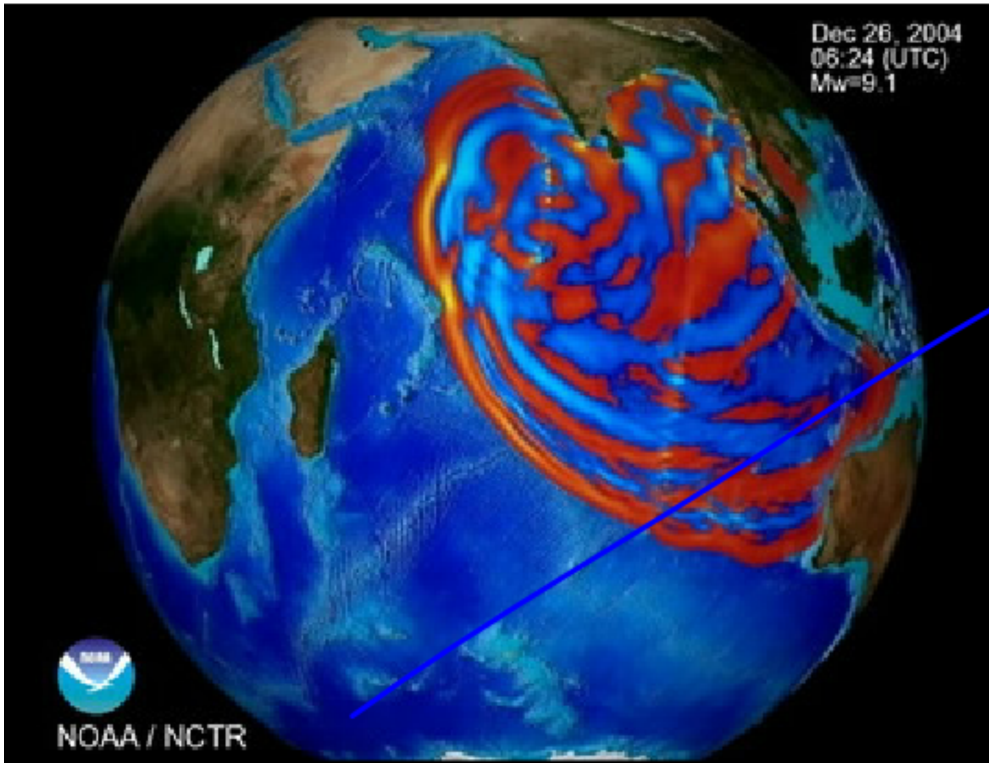
- The presentation will include an overview of new hazard and risk assessment information on earthquake and tsunami hazards in Washington State, current risk reduction strategies, success stories, and lessons that Washington and the U.S. must learn and, more importantly, apply before the next big quake strikes at home.

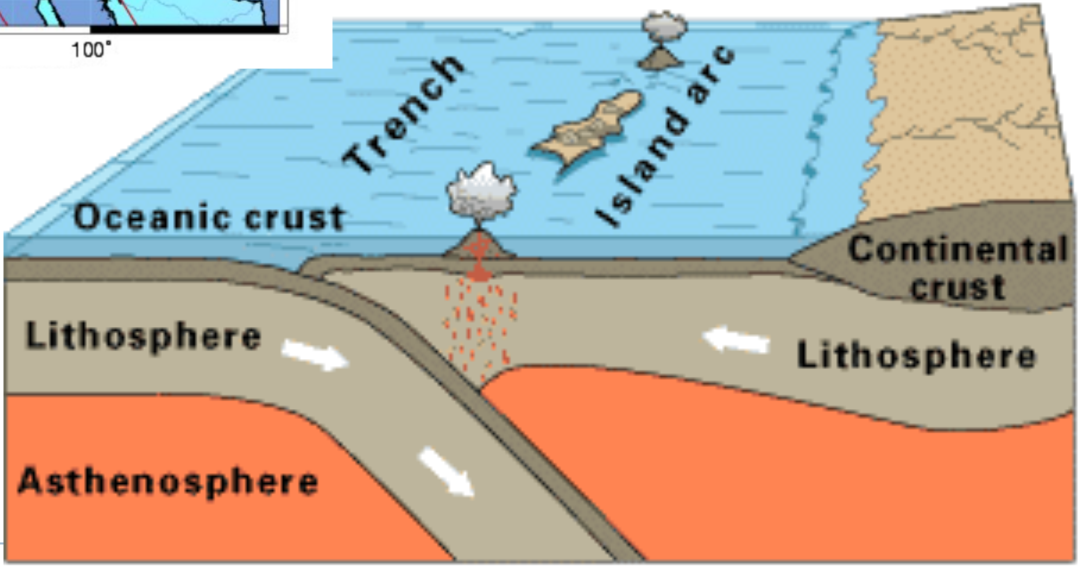
Where Have Others Been Recently?

The Not so Distant Past…

2004







Oceanic-oceanic convergence

On December 26, 2004, a magnitude 9.1 earthquake struck beneath the Indian Ocean near Indonesia, which generated a tsunami that claimed 230,000+ lives in some fourteen different countries.

This tragic event remains one of the deadliest natural disasters ever recorded.

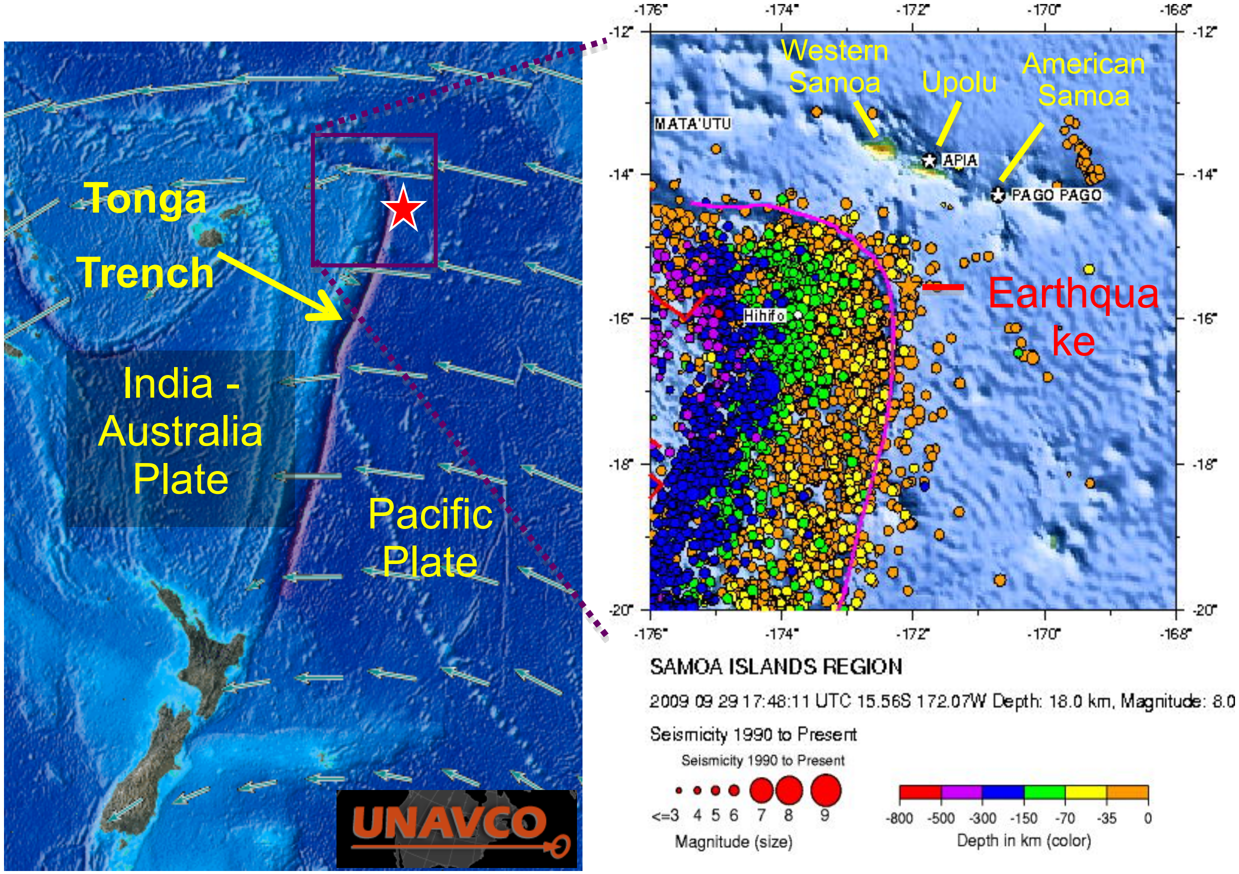
The ‘Boxing Day Tsunami’ changed the course of history and served as the impetus to pass legislation in the United States to support additional tsunami warning capability, improved understanding of tsunami hazards, and mitigation/risk reduction efforts within coastal states and communities.

2009

Magnitude 8.0 SAMOA ISLANDS REGION

Tuesday, September 29, 2009 at 17:48:11 UTC

This great earthquake occurred near the northern end of the Tonga Trench where the Pacific Plate subducts below the India – Australia Plate. This earthquake occurred about 200 km south of the island of Upolu. The rate of convergence at the Tonga Trench is about 80 mm/yr (8 cm/yr) and this is one of the most seismically active subduction zones on Earth.



SAMOA ISLANDS REGION

2009 09 29 17:48:11 UTC 15.56S 172.07W Depth: 18.0 km, Magnitude: 8.0

Seismicity 1990 to Present

Magnitude 8.0 SAMOA ISLANDS REGION

Tuesday, September 29, 2009 at 17:48:11 UTC

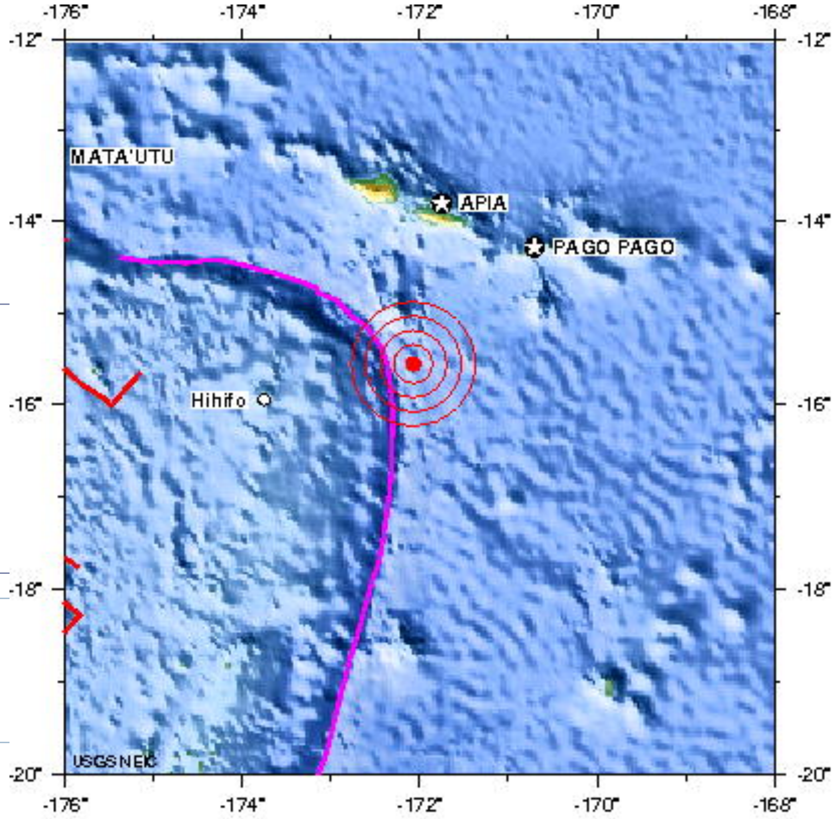
A magnitude 8.0 earthquake in the Samoa Islands region, has killed 39 people and left thousands homeless.

While there was minimal damage from the earthquake, most of the damage and all of the loss of life from this earthquake was from the resulting tsunami.

There is widespread damage to infrastructure, communications, and power. There is additional damage on the islands from landslides.

A main road in the downtown area of Fagatogo, American Samoa is flooded by water

AP Photo/Fili Sagapolutele



SAMOA ISLANDS REGION

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Earthquake Location

Magnitude 8.0 SAMOA ISLANDS REGION

Tuesday, September 29, 2009 at 17:48:11 UTC

Residents in both Samoa and American Samoa reported being shaken awake by the quake, which lasted two to three minutes.

Sulili Dusi told New Zealand's National Radio that "everything dropped on the floor and we thought the house was going to go down as well. Thank God, it didn't." Along with neighbors, they fled to high ground.

There were no immediate reports of injury or serious damage from local emergency services, but people reported cracks in some homes and items tossed from shelves.

Cars and people were swept out to sea by the fast-churning water as survivors fled to high ground, where they remained huddled hours later. Signs of devastation were everywhere, with a giant boat getting washed ashore and coming to rest on the edge of a highway and floodwaters swallowing up cars and homes. AP

Tsunami waves that swept ashore on Samoa and American Samoa early Tuesday flattened villages

Terri Chynoweth

A car is seen pushed up against a bridge after strong sea water from the tsunami filled a small stream

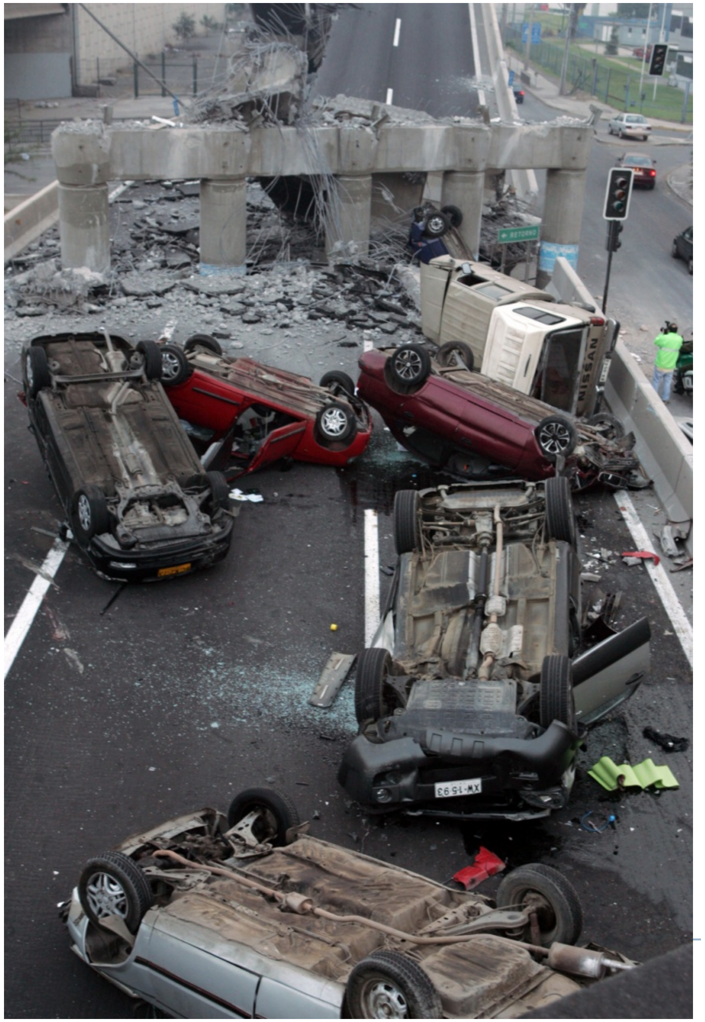
AP Photo/Fili Sagapolutele

2010

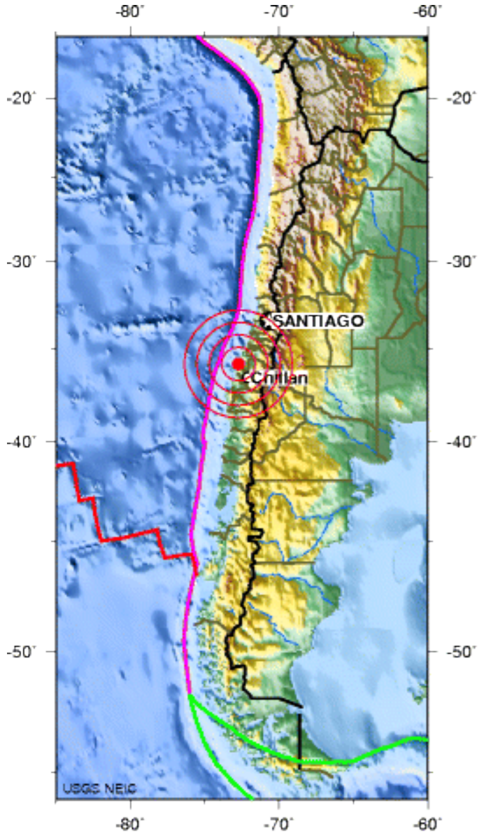
IRIS
Teachable Moments

Magnitude 8.8 OFFSHORE MAULE, CHILE
Saturday, February 27, 2010 at 06:34:17 UTC

A great 8.8-magnitude struck central Chile early Saturday. The quake hit 200 miles (325 kilometers) southwest of the capital Santiago. The epicenter was just 70 miles (115 kilometers) from Concepcion, Chile's second-largest city.



USGS



OFFSHORE MAULE, CHILE

USGS

Vehicles that were driving along a highway that collapsed during the earthquake near Santiago are seen overturned on the asphalt Saturday Feb. 27, 2010 after an 8.8-magnitude earthquake struck central Chile early Saturday.

AP Photo/David Lillo

Images courtesy of the U.S. Geological Survey

IRIS
Teachable Moments

Magnitude 8.8 OFFSHORE MAULE, CHILE

Saturday, February 27, 2010 at 06:34:17 UTC

Interior Minister Edmundo Perez Yoma said this morning's quake was the most powerful tremor to hit his country in 50 years. At this time, 708 deaths have been reported and the number of dead and injured is likely to rise considerably as communications with the most heavily affected areas are restored.

In Santiago, the capital city with a population of nearly 5 million, it was reported that many, roads were destroyed and water, electricity, and phones lines were cut to many- making communication impossible.

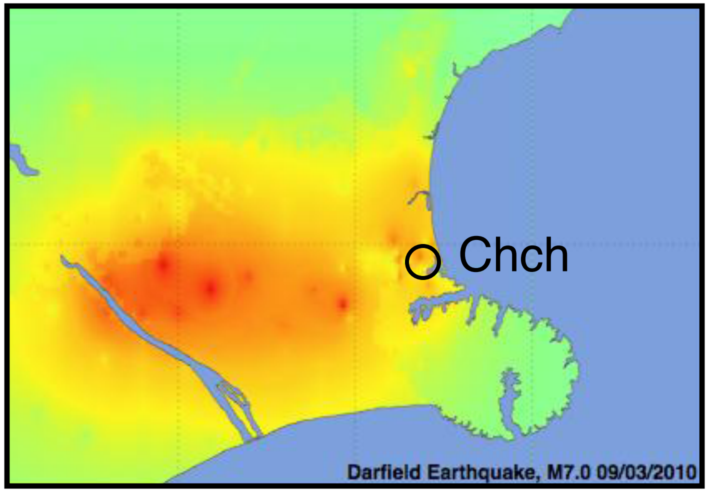
Even closer to the epicenter, Chile's second-largest city, Concepcion with ~900,000 inhabitants in the area, experienced severe ground shaking and major damage.

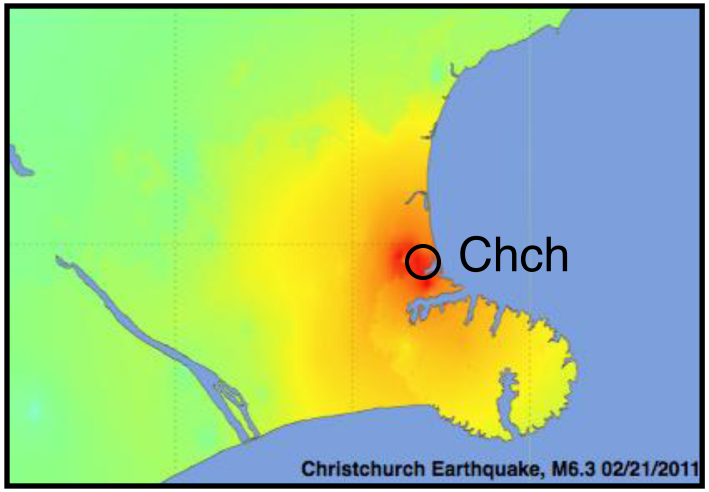
This image provided by TVN shows a building in Concepcion totally engulfed in flames following the earthquake early Saturday Feb. 27, 2010 AP

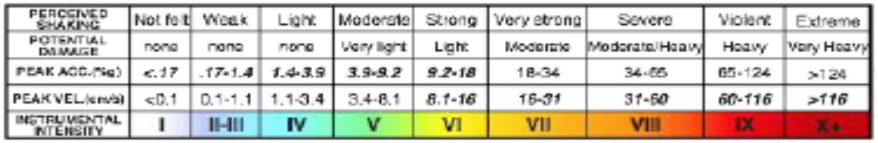
The Canterbury Earthquakes

- **September 4, 2010 @ 4:35 a.m.**
  - Magnitude 7.1
  - 25 miles west of Christchurch near Darfield
  - 6 miles deep

- **February 22, 2011 @12:51 p.m.**
  - Magnitude 6.3
  - 3 miles southwest of Christchurch
  - 3 miles deep

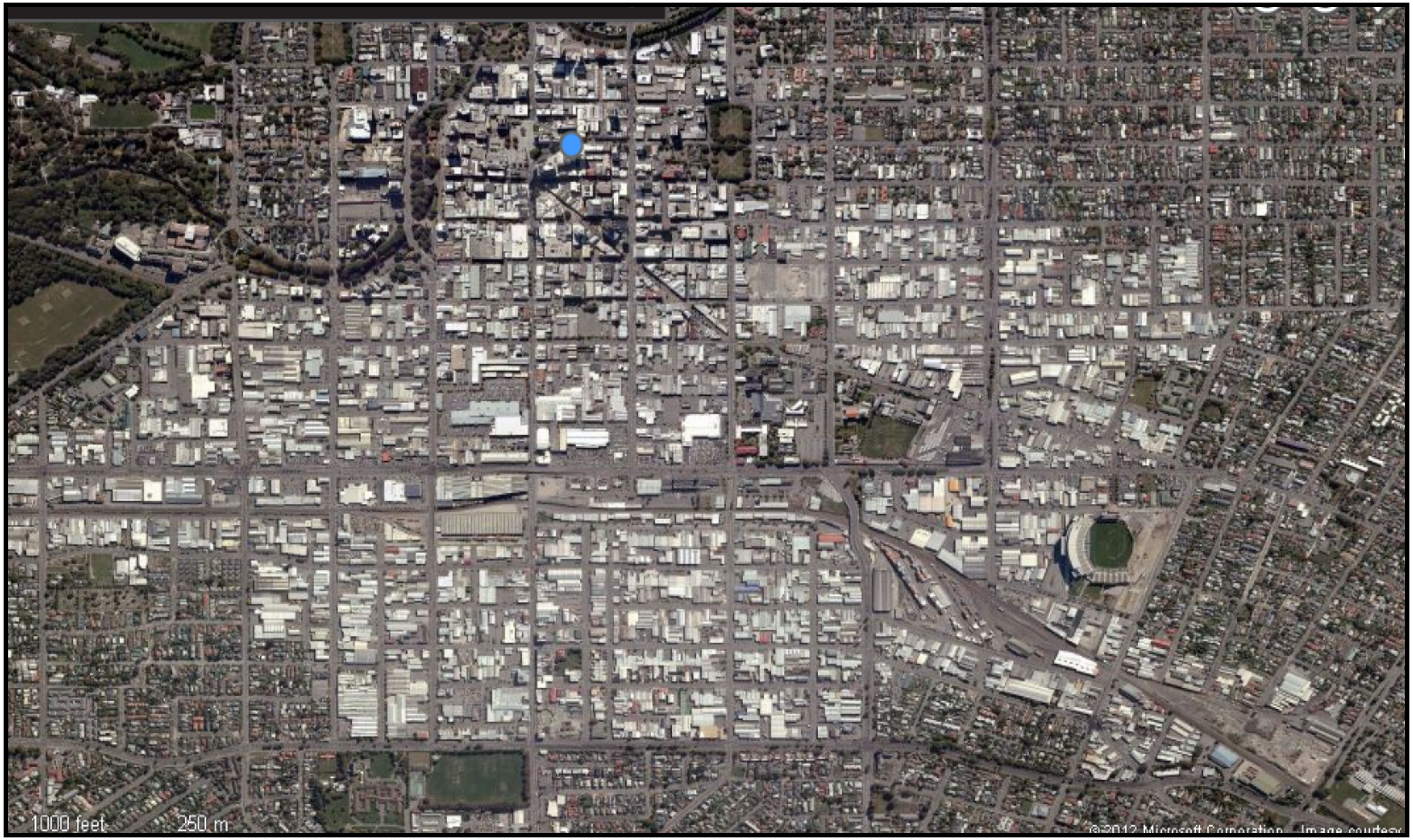




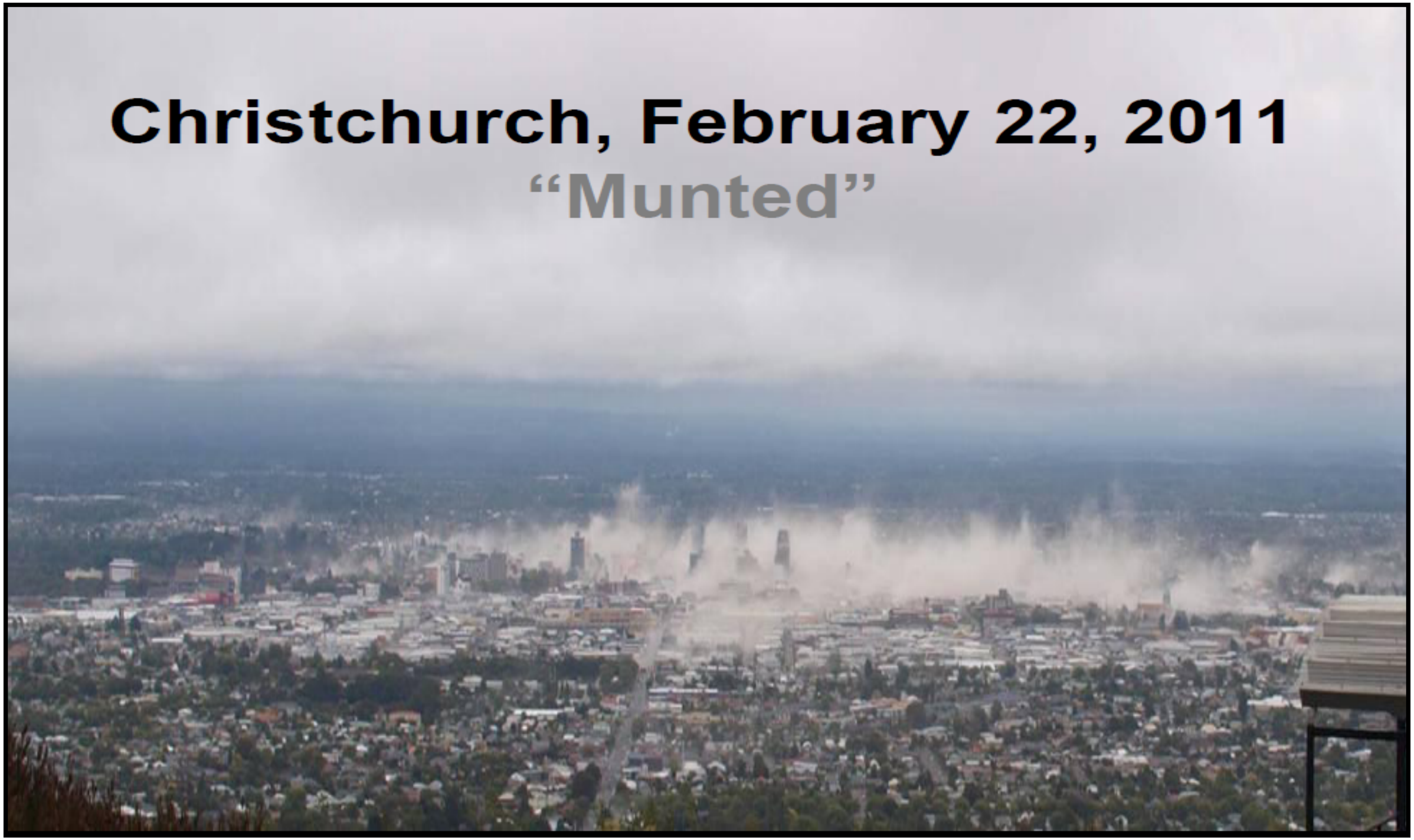


PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Pre-Earthquake:
Christchurch Central Business District (CBD)



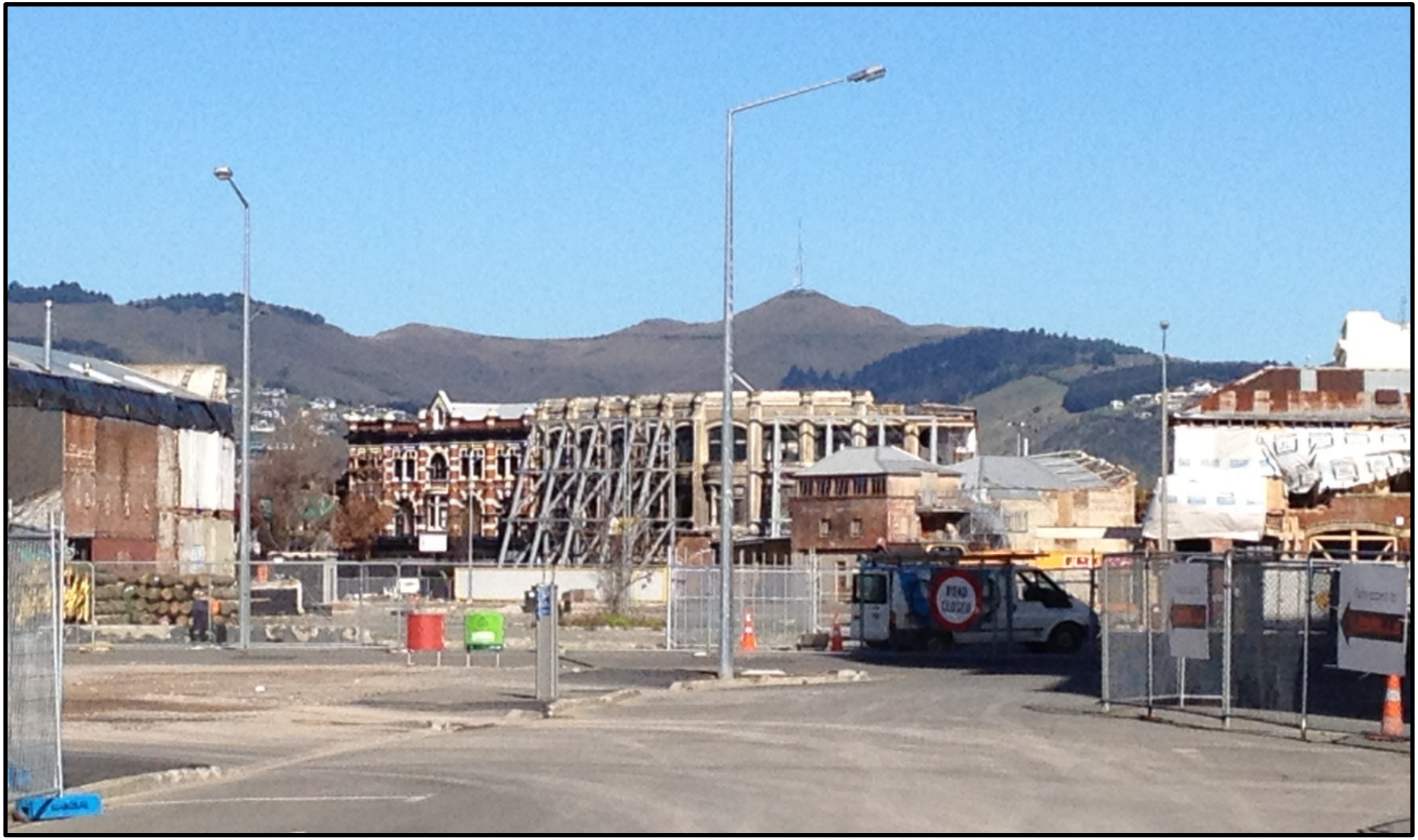
During Earthquake: Christchurch Central Business District



Christchurch, February 22, 2011

"Munted"

“Downtown” Christchurch 2-Years Later



Post-Earthquake: (Recovery in Process)
Christchurch Central Business District

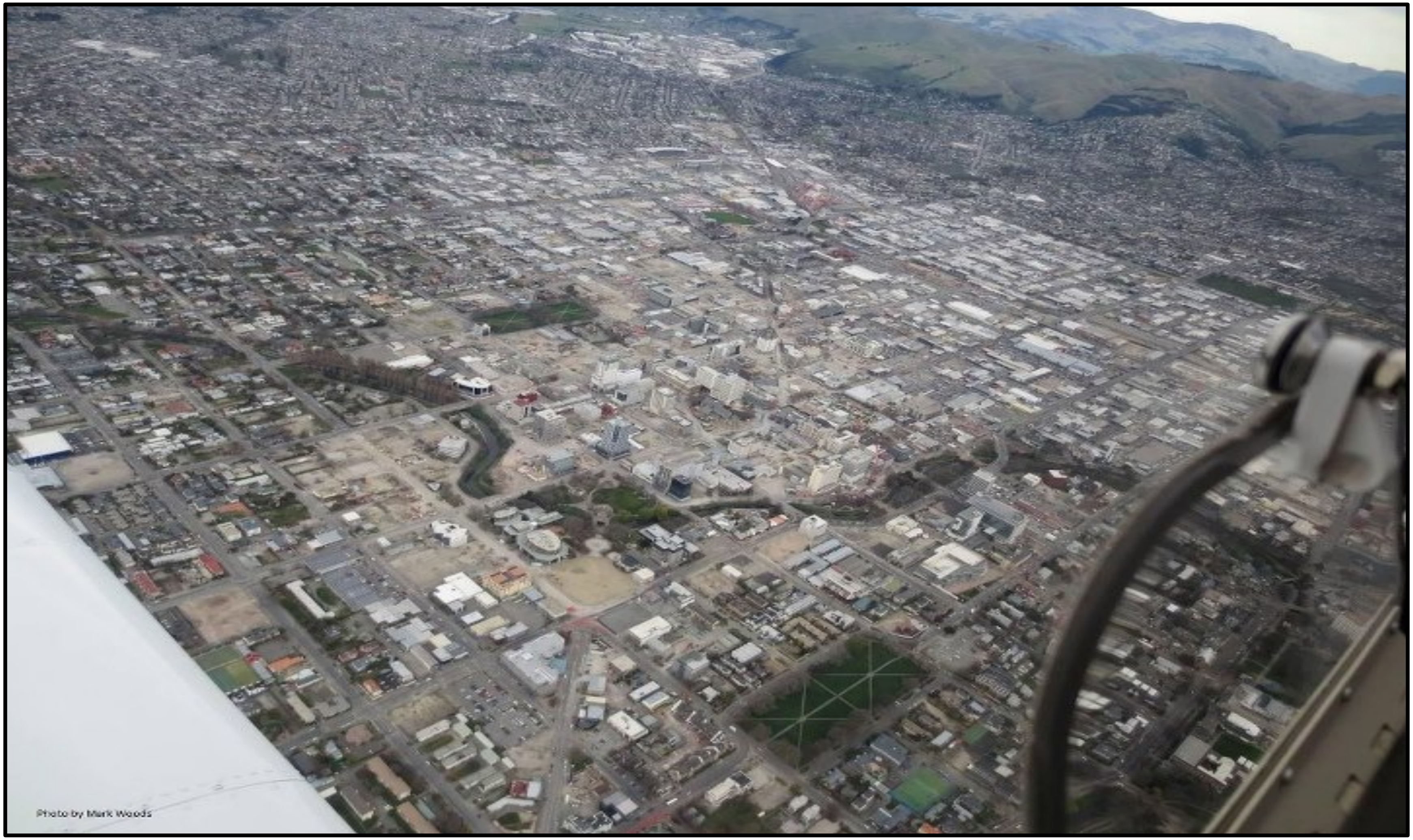
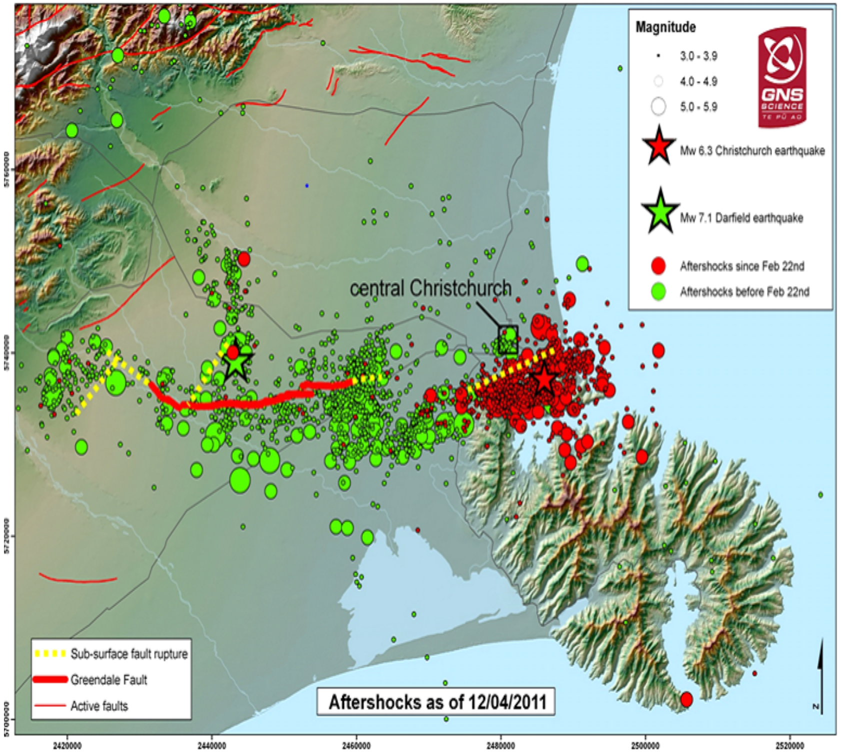


Photo by Mark Woods

Key Lessons from Christchurch: Hazard Assessment & Pre-Disaster Mitigation Really Matter…and Really Work!



Source: GNS Science, 2011

- Hazard Assessment is Essential:
  - Prior to this earthquake sequence, the Greendale Fault had not been identified.
- Mitigation Works:

"For example, the mitigation measures put in place after a vulnerability study (1994-97) ***cost $6 million but are estimated to have saved $60-65 million in direct asset replacement costs as result of the earthquakes in addition to the contribution to rapid restoration of services***."

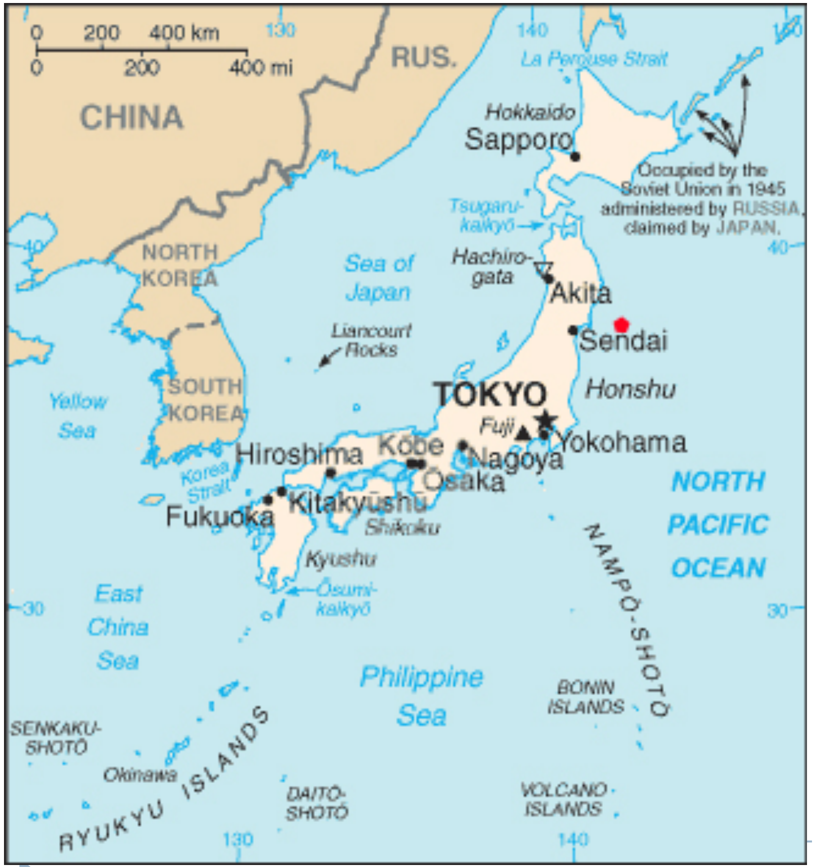
- Source: Review of the Civil Defence Emergency Management Response to the 22 February Christchurch Earthquake, 29 June 2012

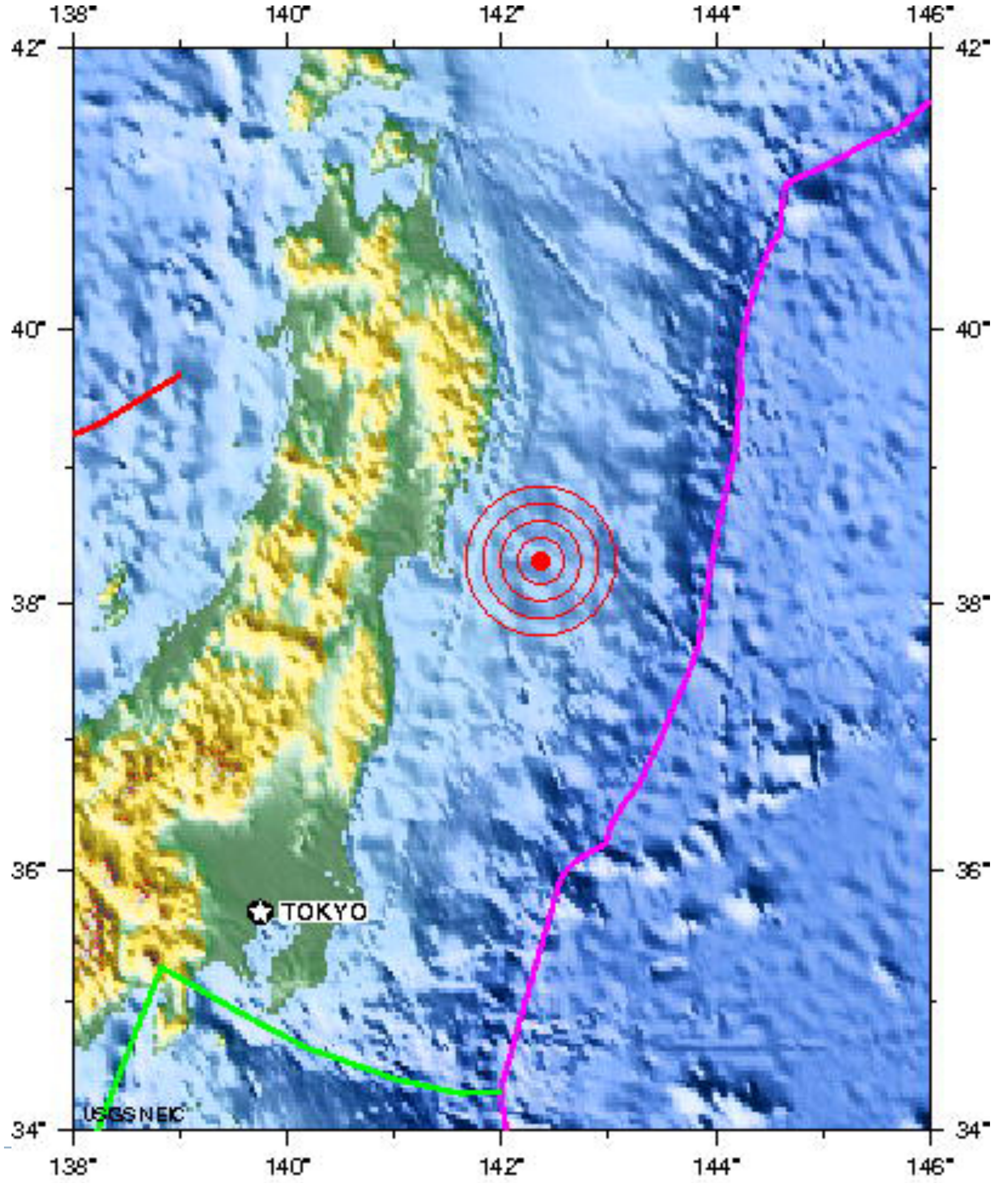
And then came the Great East Japan Earthquake…

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN

Friday, March 11, 2011 at 05:46:23 UTC

This earthquake occurred 130 km (80 miles) east of Sendai, Honshu, Japan and 373 km (231 miles) northeast of Tokyo, Japan.





Images courtesy of the US Geological Survey

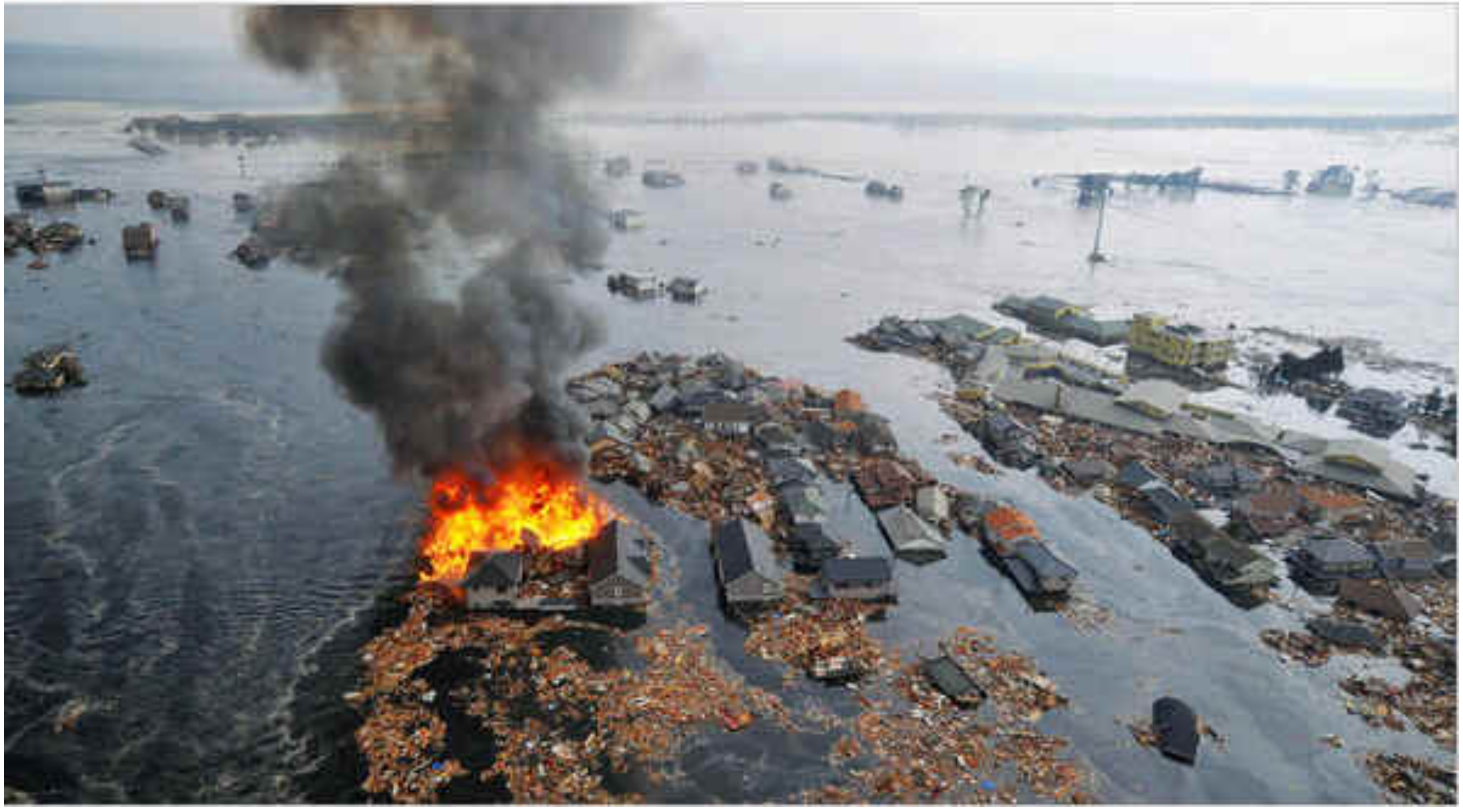
Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN

Friday, March 11, 2011 at 05:46:23 UTC

Japan was struck by a magnitude 9.0 earthquake off its northeastern coast on 3.11.2011. This is one of the largest earthquakes that Japan has ever experienced.

USGS

In downtown Tokyo, large buildings shook violently and there is severe flooding due to a tsunami generated by the earthquake.



Part of houses swallowed by tsunami burn in Sendai, Miyagi Prefecture (state) after Japan was struck by a strong earthquake off its northeastern coast Friday, March 11, 2011.

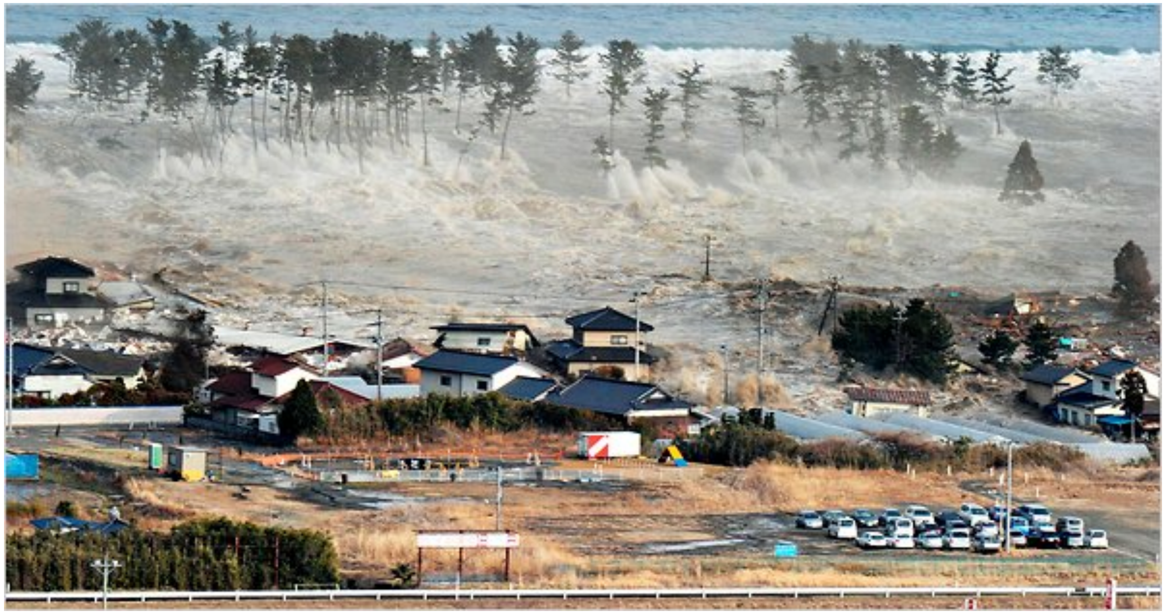
New York Times

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN

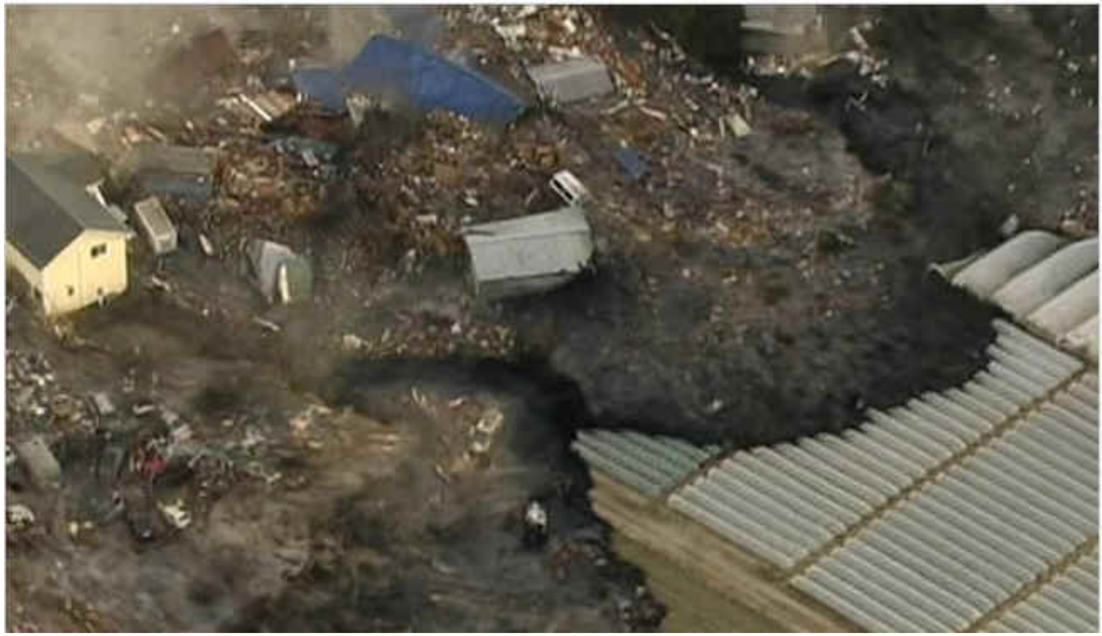
Friday, March 11, 2011 at 05:46:23 UTC

Tsunami waves swept away houses and cars in northern Japan and pushed ships aground.

The tsunami waves traveled far inland, the wave of debris racing across the farmland, carrying boats and houses with it.



The tsunami, seen crashing into homes in Natori, Miyagi prefecture. *AP*

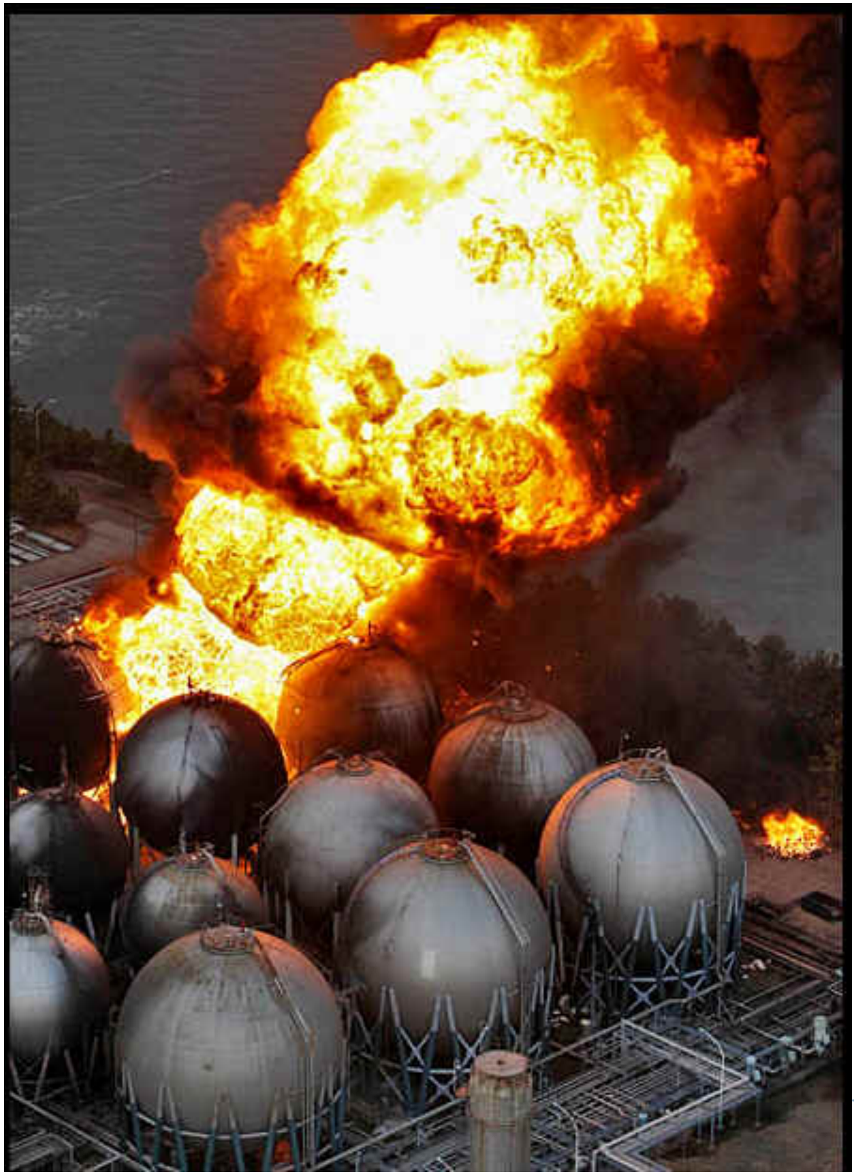


Houses were washed away by tsunami in Sendai, Miyagi Prefecture in eastern Japan, after Japan was struck by a magnitude 9.0 earthquake off the northeastern coast.

New York Times

Magnitude 9.0 NEAR THE EAST COAST OF HONSHU, JAPAN

Friday, March 11, 2011 at 05:46:23 UTC



CNN reported “The quake rattled buildings and toppled cars off bridges and into waters underneath. Waves of debris flowed like lava across farmland, pushing boats, houses and trailers toward highways.”

Additionally, a number of fires broke out including one at an oil refinery which at this time, is burning out of control.

Giant fireballs rise from a burning oil refinery in Ichihara, Chiba Prefecture (state) after Japan was struck by a strong earthquake off its northeastern coast Friday, March 11, 2011.

Los Angeles Times

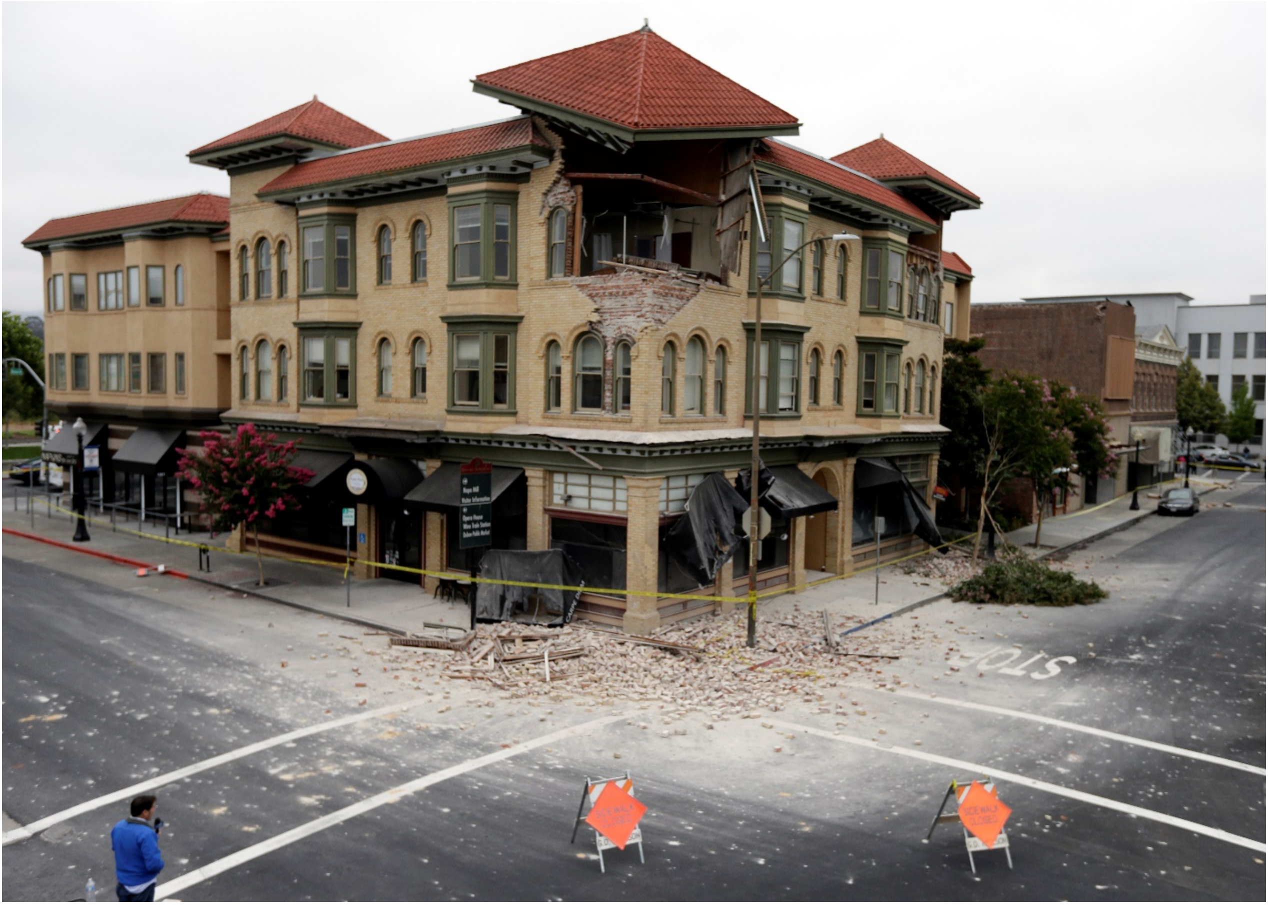
2014

Magnitude 6.0 SAN FRANCISCO BAY AREA

Sunday, August 24, 2014 at 10:20:44 UTC

USGS

Early Sunday morning, the Bay Area was awakened by a magnitude 6.0 earthquake, the biggest earthquake the region has experienced since the Loma Prieta earthquake nearly 25 years ago. The earthquake was centered 6 miles (10 km) south of the city of Napa, which is located about 50 miles northeast of San Francisco.



A building is partially collapsed due to a 6.0-magnitude earthquake, Sunday, Aug. 24, 2014, in Napa, Calif. A large earthquake rolled through California's northern Bay Area early Sunday, damaging some buildings, igniting fires, knocking out power to tens of thousands and sending residents running out of their homes in the darkness.

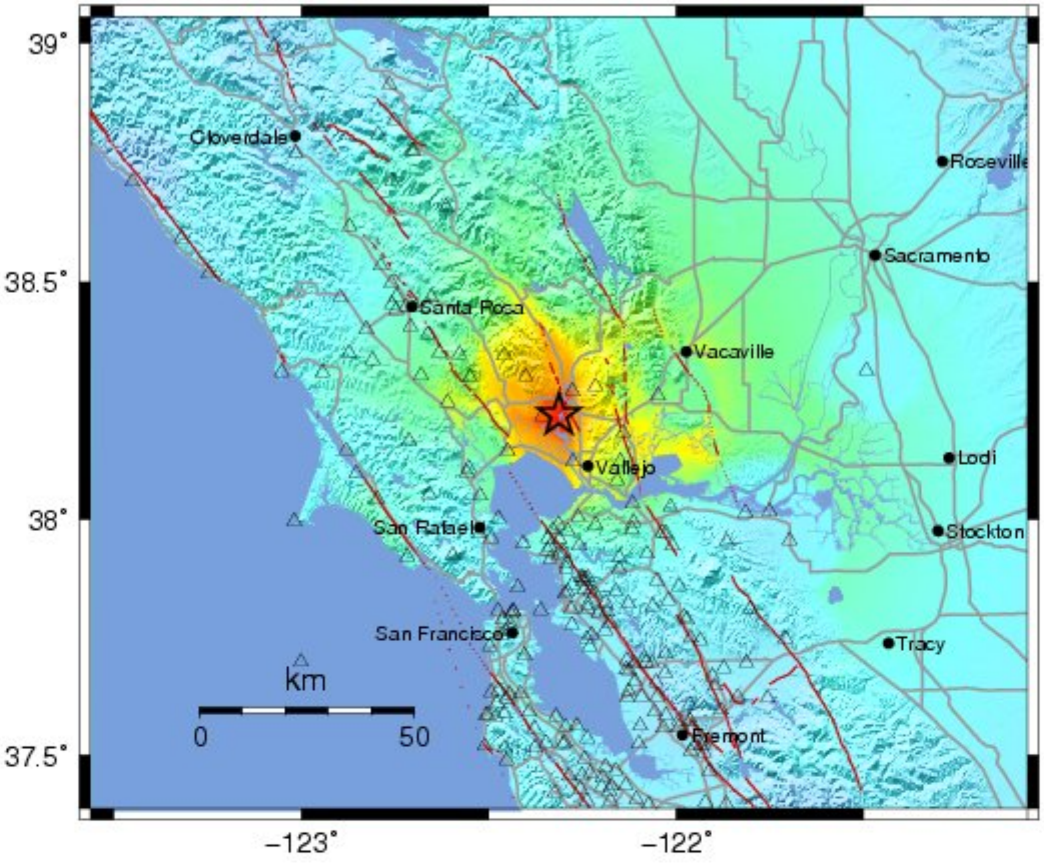
(AP Photo/Ben Margot)

Magnitude 6.0 SAN FRANCISCO BAY AREA

Sunday, August 24, 2014 at 10:20:44 UTC

The Modified-Mercalli Intensity scale is a twelve-stage scale, from I to XII, that indicates the severity of ground shaking. The earthquake occurred near the north shore of San Pablo Bay. The bayshore areas in the San Francisco Bay region are underlain by landfill and bay mud and have experienced disproportionately greater damage during historic earthquakes. Such damage is caused by soil failure in the fills and amplification of ground shaking by the soft bay mud.

Modified Mercalli Intensity	**Perceived Shaking**
X	Extreme
IX	Violent
VIII	Severe
VII	Very Strong
VI	Strong
V	Moderate
IV	Light
II-III	Weak
I	Not Felt



USGS Estimated shaking Intensity from M 6.0 Earthquake

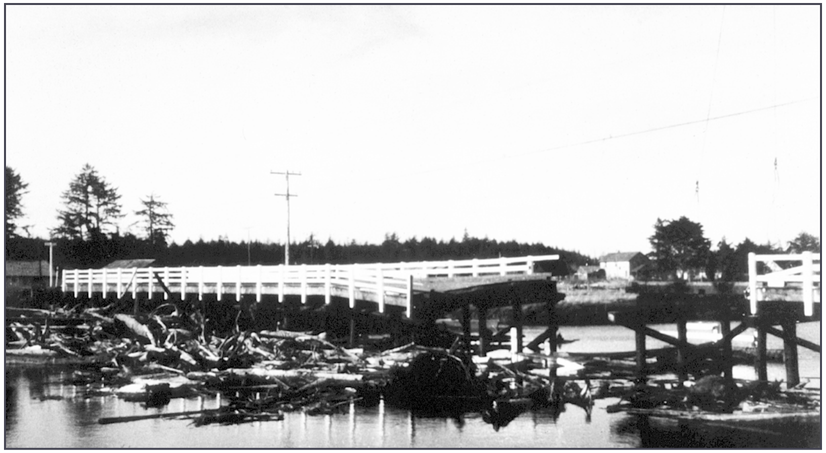
Image courtesy of the US Geological Survey

Where has Washington Been?

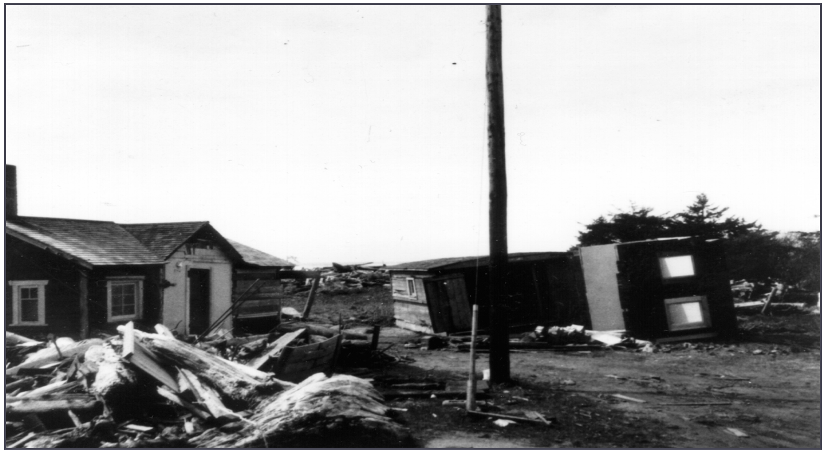
Our Past…

Great 1964 Alaska Earthquake & Tsunami: Effects in Washington State

- **March 27, 1964 @ 5:36 p.m.**
  - Magnitude 9.2
  - Most powerful earthquake recorded in U.S. history and second largest of all time (Chile M9.5, 1960)
  - Resulting tsunami peak was about 220 feet in Valdez inlet and many others locations were over 50 feet
  - Entire west coast and Hawaii affected from tsunami, especially California and Oregon.
  - The wave height in Washington was about 10-12 feet



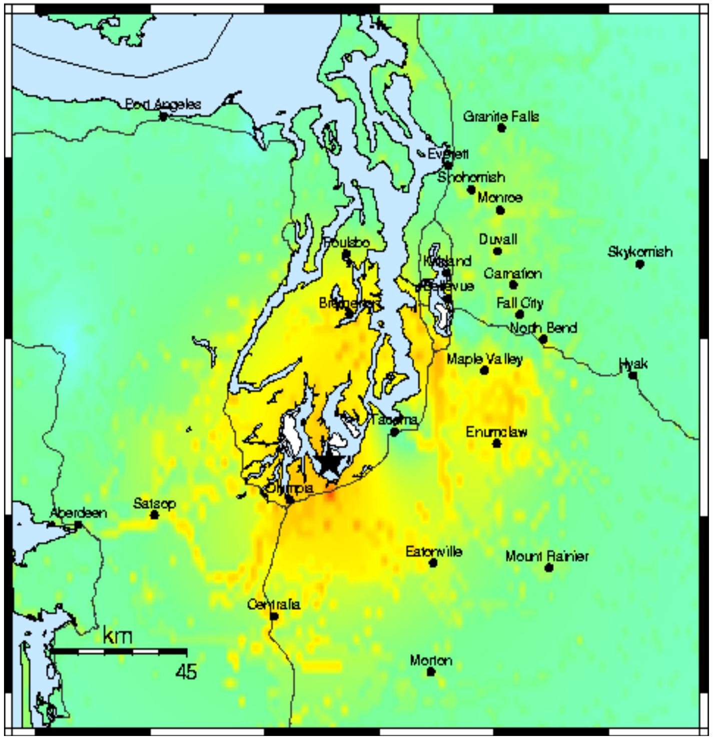
Highway 109 bridge over Copalis River, WA

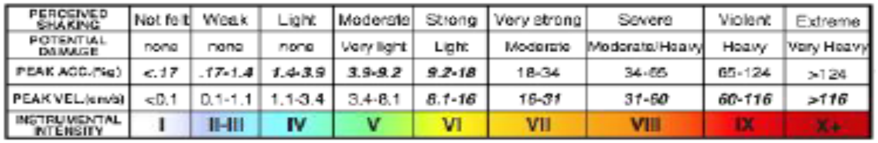


Houses torn apart at Pacific Beach, WA

14th Anniversary of the Nisqually Earthquake

- **February 28, 2001 @ 10:54 a.m.**
  - Magnitude 6.8
  - 11 miles northeast of Olympia, Washington
  - 31.6 miles deep
  - Felt from British Columbia to Montana
  - Amazingly, there were no deaths, ~400 injuries
  - Estimated losses of $1 - $4 billion
  - Final FEMA Public Assistance closeout was just a short 2 years ago





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POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Courtesy: USGS, 2001

We have come a long way from 1964…2001…and even 2004

The Present…

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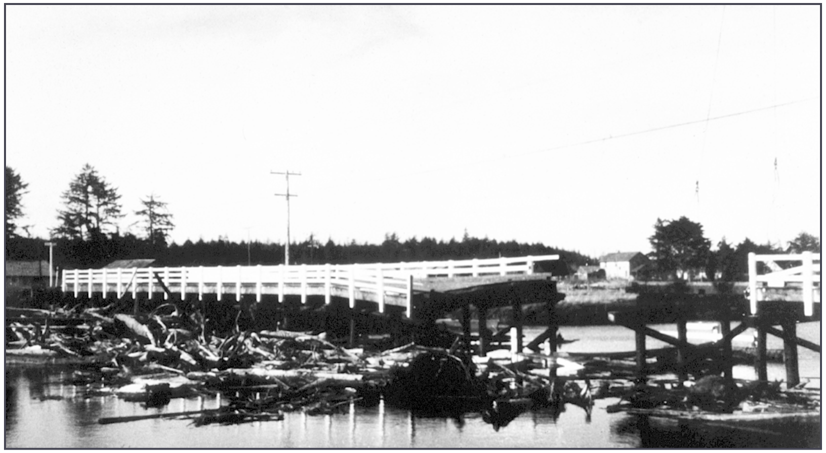

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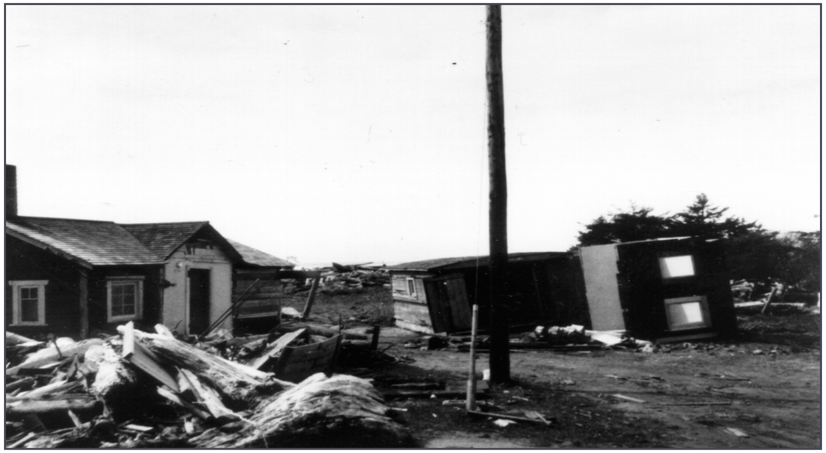

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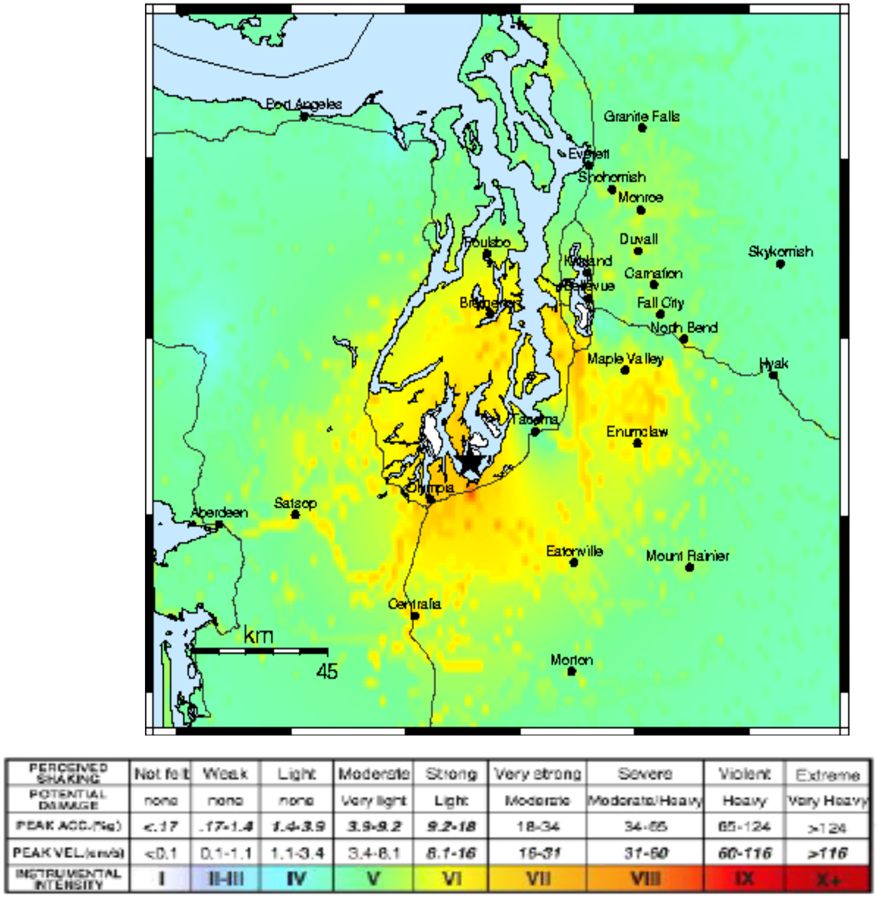

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Courtesy: USGS, 2001

We have come a long way from 1964…and even 2001

The Present…

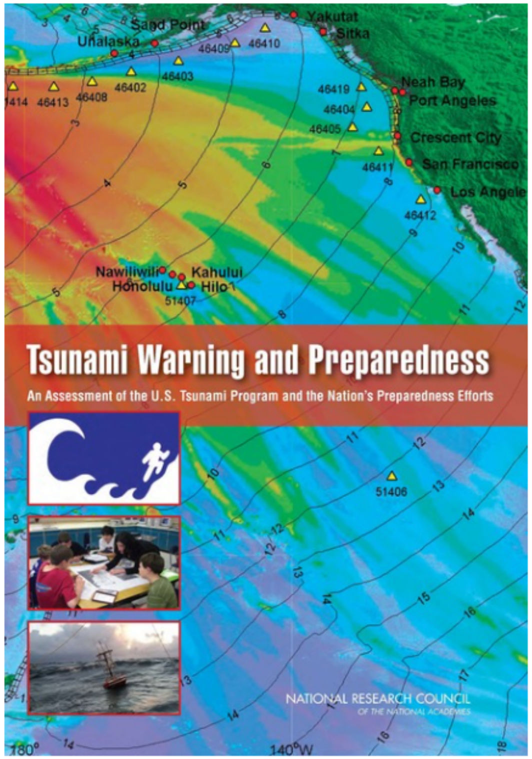
We HAVE learned (and are STILL learning) incredibly valuable lessons from Japan…and Chile… and Samoa…and…

The Takeaway:

We continue to incorporate new research, science, data, and information into earthquake & tsunami hazard assessments and then *APPLY* what we have learned in collaboration with our local and tribal partners in order to truly become better prepared and more resilient.

Consistency is Critical

At the direction of Congress, the National Academy of Science completed a review of the National Tsunami Program from 2010 - 2011. They made several recommendations that are being implemented to ensure consistency across borders.



Tsunami Warning and Preparedness

An Assessment of the U.S. Tsunami Program and the Nation's Preparedness Efforts

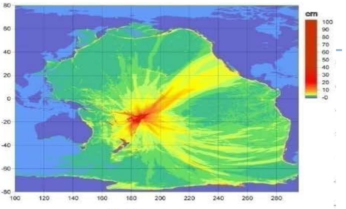
NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

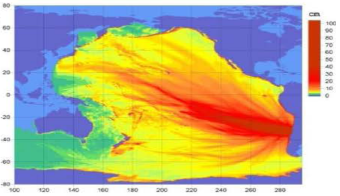
http://www.nap.edu/catalog/12628/tsunami-warning-and-preparedness-an-assessment-of-the-us-tsunami

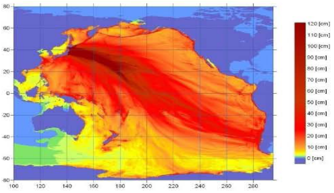
- **Recommendation:** NOAA and its NTHMP partners should institute a periodic assessment of the sources of tsunamis that threaten the United States.
- **Recommendation:** The NTHMP should reduce unnecessary and costly disparities in inundation modeling approaches among states and territories. ***The NTHMP should conduct modeling efforts consistently across political boundaries*** and execute efforts through a cooperative partnership among NOAA, the USGS, and NTHMP members.

(emphasis added)

Based on these recommendations, Washington State and Oregon are using inundation models that have met NOAA standards as well as the same tsunami source parameters.

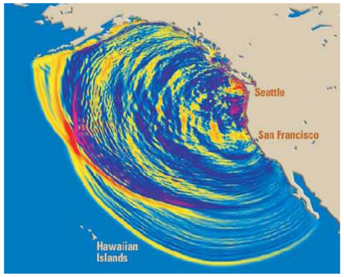

2009 Samoa


2010 Chile


2011 Japan

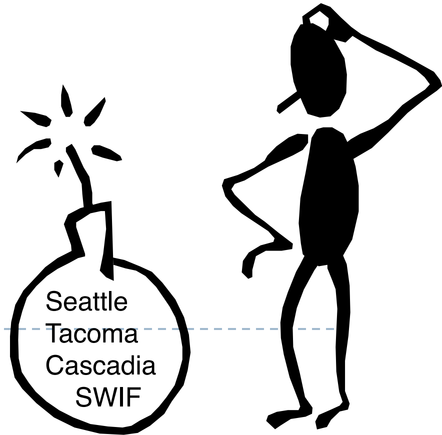
- **DISTANT** Tsunamis:
  - Events with 2+ hours arrival time from around Pacific Rim
  - Time & capability to issue ‘official’ warnings
  - Much smaller than local tsunamis
  - NOAA Tsunami Warning Centers (TWCs), Dart Buoys provide useful data

- **LOCAL** Tsunamis:
  - Events with 5-30 min. arrival time & most casualties occur w/in 45 min.
  - Massive tsunamis with large inland penetration possible
  - People must be trained on life-safety protective actions & act immediately!
  - TWCs & buoys ineffective for initial life-safety actions

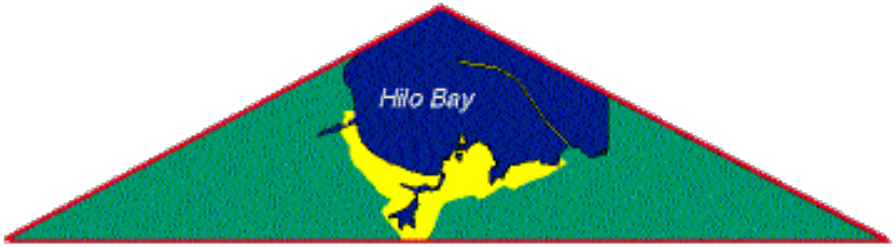


20?? United States

- ***“The time’s, they are a changin’?”***
  - M8+ EQ in the next 50-years:
    - 10 – 14 % Northern CSZ (USGS)
    - 37 % Southern CSZ (C. Goldfinger)



Hazard Assessment



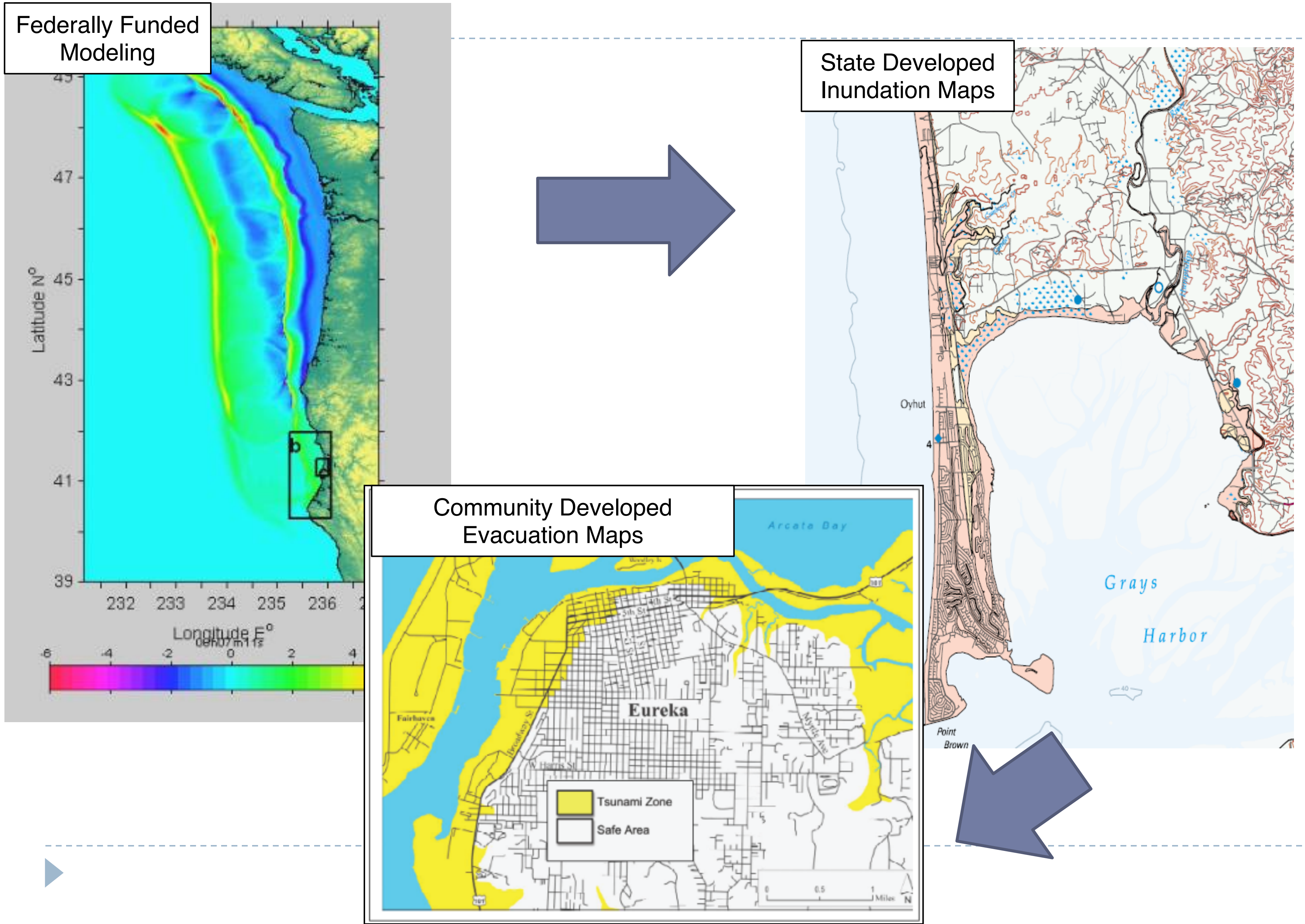
Hazard Assessment

=

State tsunami programs in collaboration with federal, state, and local researchers conduct:

- Scientific Studies and Workshops
- Tsunami Modeling for scenarios to ensure life-safety
- Tsunami Inundation Mapping
- Evacuation Mapping

Tsunami Inundation Maps

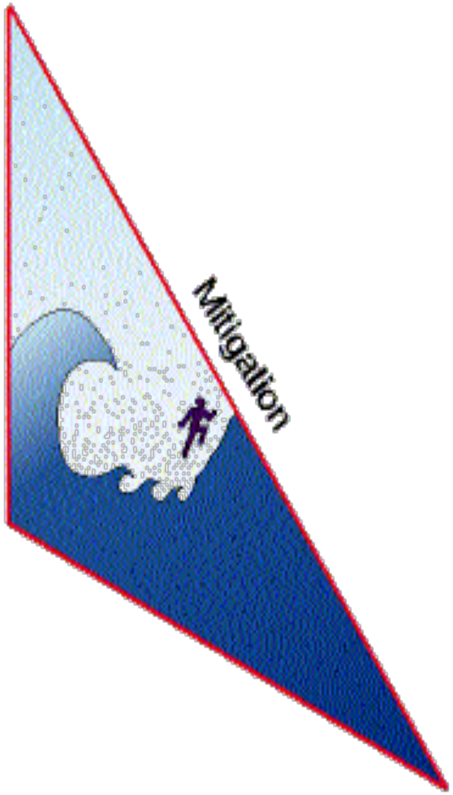


Federally Funded Modeling

State Developed Inundation Maps

Community Developed Evacuation Maps

“Community-based” Preparedness & Mitigation Efforts



State tsunami programs in collaboration with federal & local partners to:

- Provide Tsunami Education

  (Incorporate ‘evidence-based’ social science approaches)

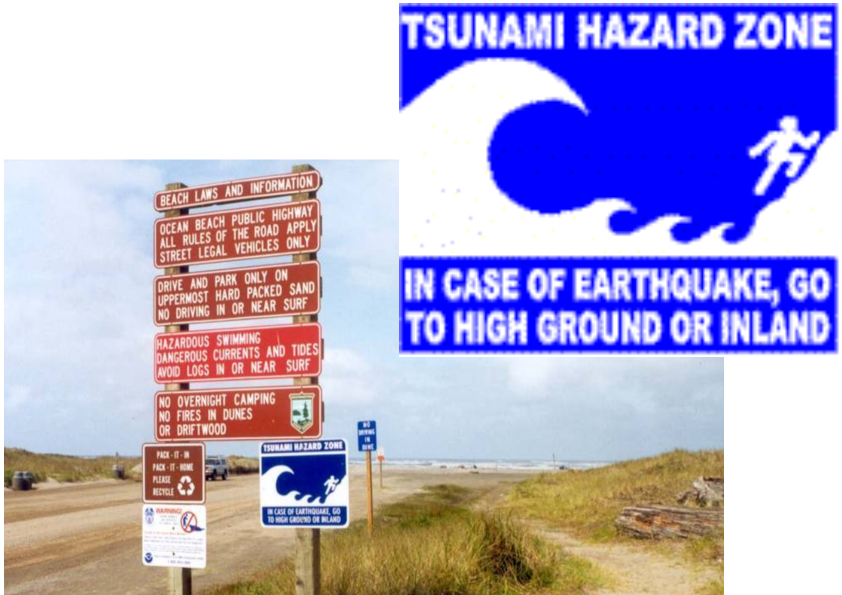
Target Audiences:

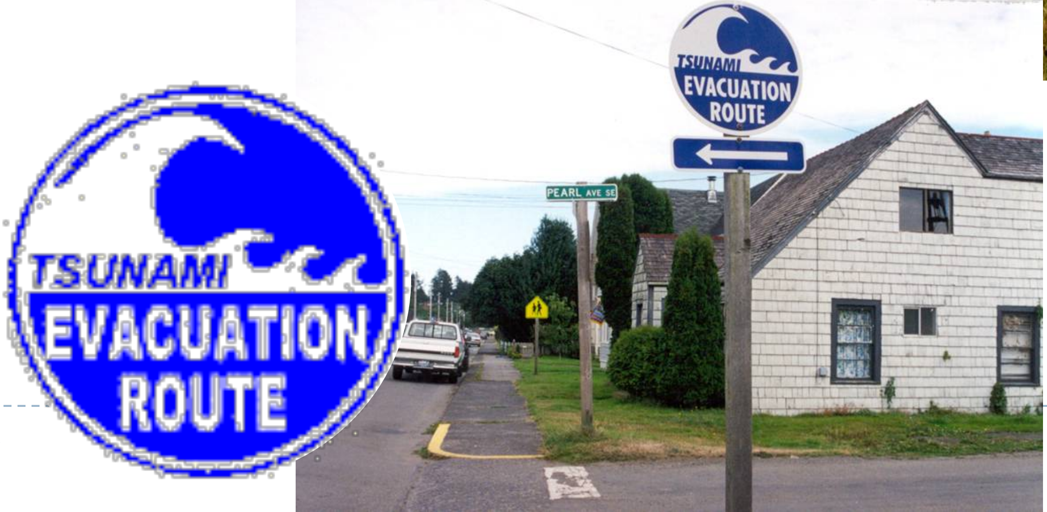
- Coastal Residents
- Tourists
- Maritime Community
- First Responders
- School Aged Children
- Media Partners
- Hospitality Industry
- Local Businesses
- Land Use Planners

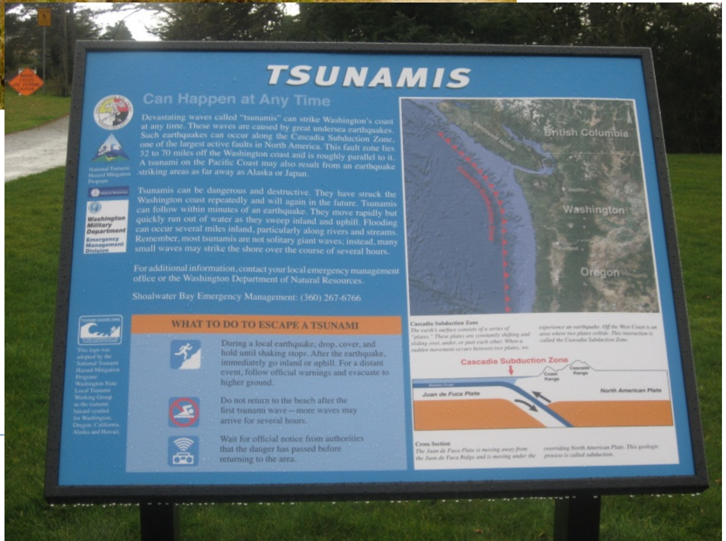
- Install Tsunami Signage
- Support Local Jurisdiction Needs

Tsunami Signage

- ➢ Pre-event Awareness
- ➢ Evacuation Routes
  - ➢ Driving & Walking
- ➢ Consistent Design & Message throughout U.S.
- ➢ Life Safety Signs

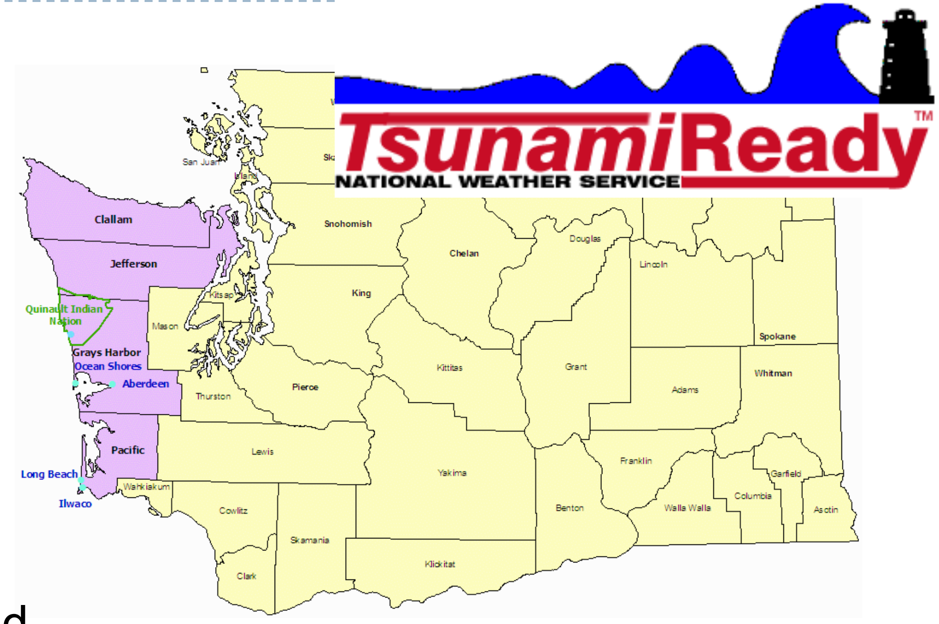

TSUNAMI HAZARD ZONE
IN CASE OF EARTHQUAKE, GO TO HIGH GROUND OR INLAND
BEACH LAWS AND INFORMATION
OCEAN BEACH PUBLIC HIGHWAY ALL RULES OF THE ROAD APPLY STREET LEGAL VEHICLES ONLY
DRIVE AND PARK ONLY ON UPPERMOST HARD PACKED SAND NO DRIVING IN OR NEAR SURF
HAZARDOUS SWIMMING DANGEROUS CURRENTS AND TIDES AVOID LOGS IN OR NEAR SURF
NO OVERNIGHT CAMPING NO FIRES IN DUNES OR DRIFTWOOD
PACK-IT-IN PACK-IT-HOME PLEASE RECYCLE
WARNING!
NO DRIVING IN DUNE




TSUNAMIS
Can Happen at Any Time
Devastating waves called "tsunamis" can strike Washington's coast at any time. These waves are caused by great undersea earthquakes. Such earthquakes can occur along the Cascadia Subduction Zone, one of the largest active faults in North America. This fault zone lies 32 to 70 miles off the Washington coast and is roughly parallel to it. A tsunami on the Pacific Coast may also result from an earthquake striking areas as far away as Alaska or Japan.
Tsunamis can be dangerous and destructive. They have struck the Washington coast repeatedly and will again in the future. Tsunamis can follow within minutes of an earthquake. They move rapidly but quickly run out of water as they sweep inland and uphill. Flooding can occur several miles inland, particularly along rivers and streams. Remember, most tsunamis are not solitary giant waves; instead, many small waves may strike the shore over the course of several hours.
For additional information, contact your local emergency management office or the Washington Department of Natural Resources.
Shoalwater Bay Emergency Management: (360) 267-6766
National Tsunami Hazard Mitigation Program
Washington Military Department Emergency Management Division
WHAT TO DO TO ESCAPE A TSUNAMI
During a local earthquake; drop, cover, and hold until shaking stops. After the earthquake, immediately go inland or uphill. For a distant event, follow official warnings and evacuate to higher ground.
Do not return to the beach after the first tsunami wave—more waves may arrive for several hours.
Wait for official notice from authorities that the danger has passed before returning to the area.
This logo was adopted by the National Tsunami Hazard Mitigation Program/ Washington State Local Tsunami Working Group as the tsunami hazard symbol for Washington, Oregon, California, Alaska and Hawaii.
British Columbia
Washington
Oregon
Cascadia Subduction Zone
Juan de Fuca Plate
North American Plate
Cross Section

Preparedness Advancements

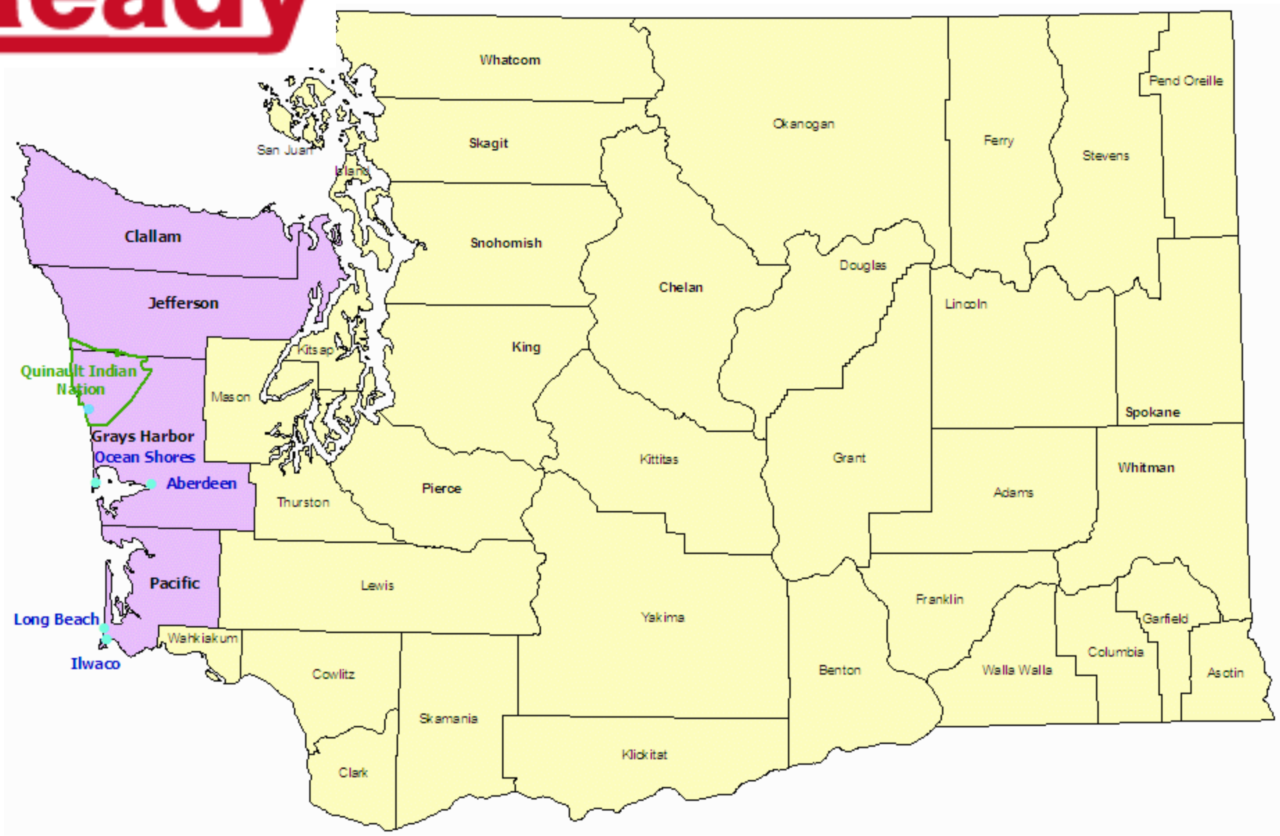
- In 2004, there was one TsunamiReady community, Ocean Shores.
- In 2014, there are 16.



Washington

Aberdeen
Hoquiam
Clallam County
Grays Harbor County
Jefferson County
Ocean Shores
Quinault Indian Nation
Lower Elwha Tribe

South Bend
Raymond
Shoalwater Bay Tribe
Ilwaco
Long Beach
Pacific County
Westport
Makah Tribe



Washington

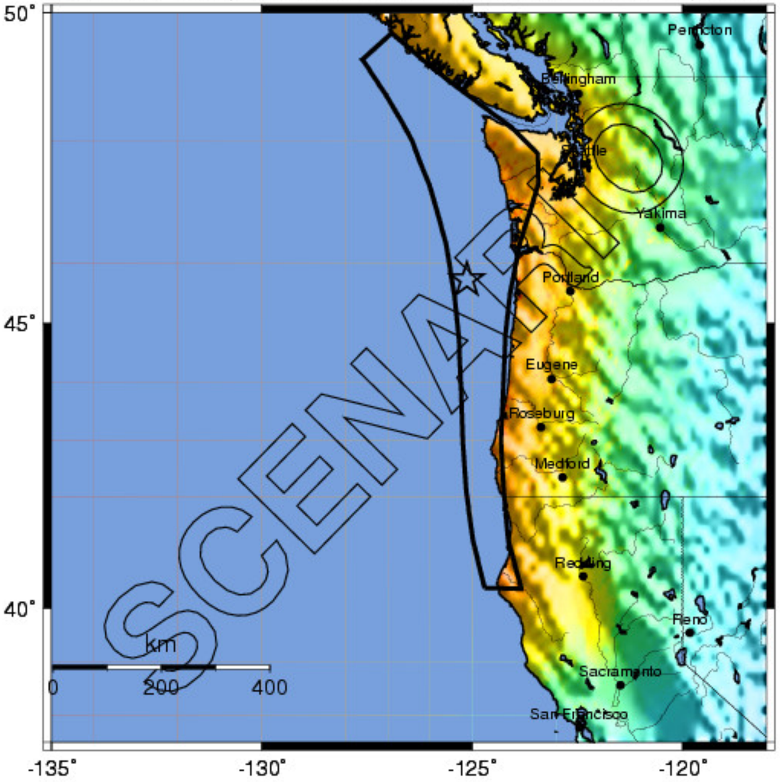
Aberdeen
Clallam County
Grays Harbor County
Jefferson County
Ocean Shores
Quinault Indian Nation
Ilwaco*
Long Beach
Pacific County

What would a repeat of the 1964 Alaska Earthquake and Tsunami Look Like in the Lower 48? The Cascadia Earthquake Scenario

- Magnitude 9.0
- Felt region-wide
- Shaking intensities greatest along coast & where local conditions amplify seismic waves
  - Injuries: 30,000 +
  - Fatalities: 10,000 +
  - Economic losses: $81 + billion in Oregon & Washington alone.

Source: Cascadia Region Earthquake Workgroup (www.crew.org)

-- Earthquake Planning Scenario --
ShakeMap for Casc9.0_expanded Scenario
Scenario Date: Tue Sep 20, 2011 12:00:00 GMT M 9.0 N45.73 W125.12 Depth: 0.0km

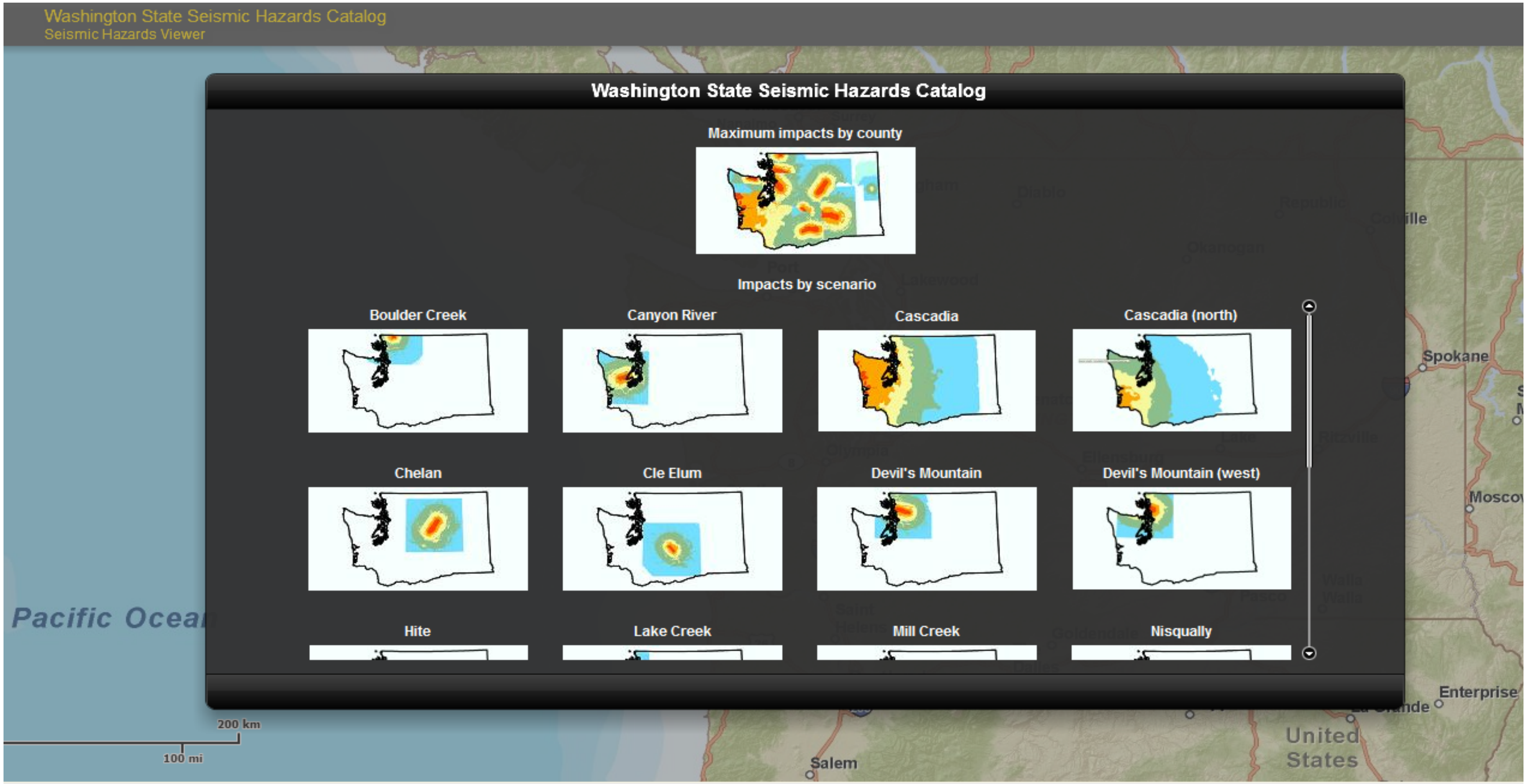


PLANNING SCENARIO ONLY -- Map Version 2 Processed Thu Sep 22, 2011 06:44:54 PM MDT

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<.17	.17-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Image Source: USGS

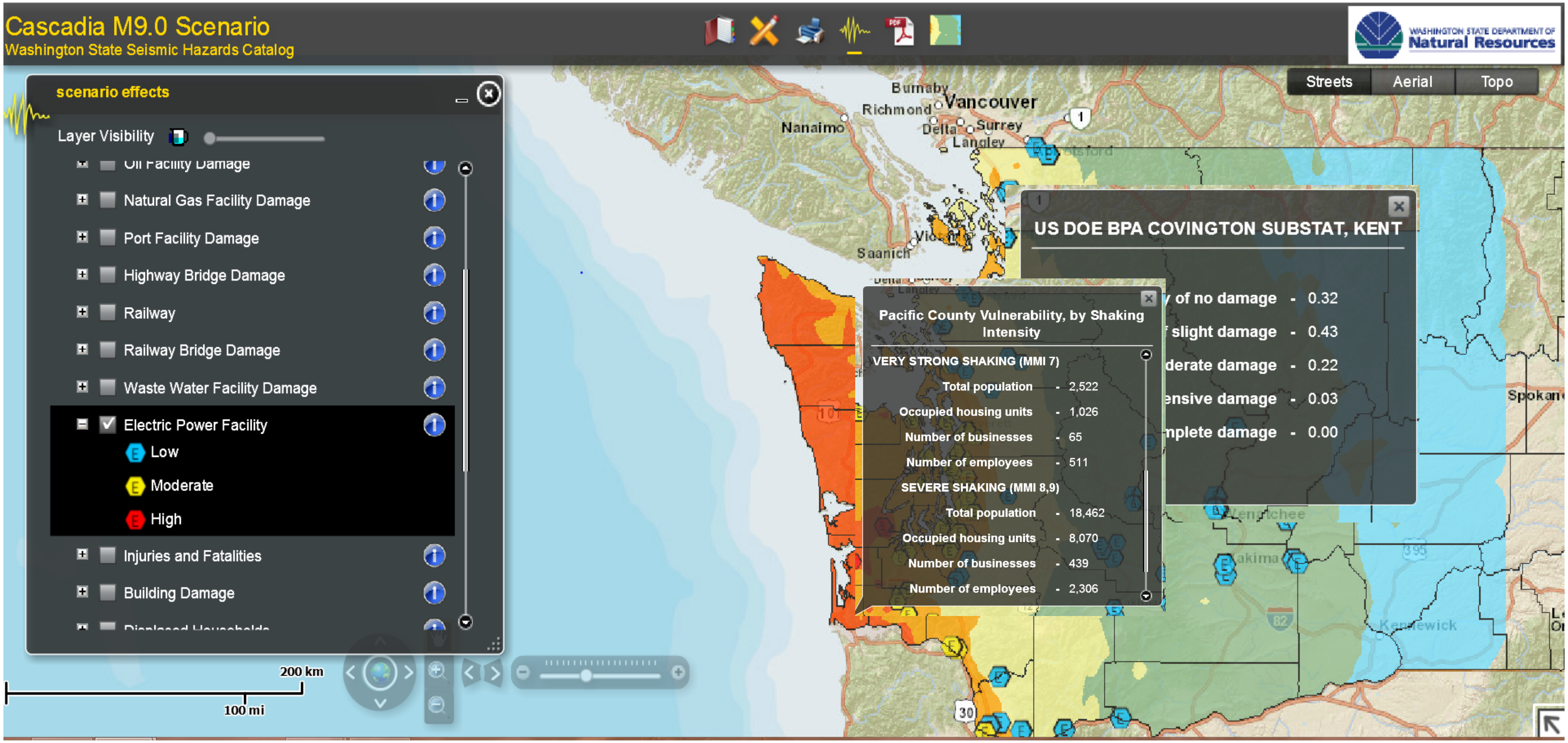
Washington State Earthquake Scenario Catalog: A Virtual Playbook for Natural Hazards Management



Suite of Materials (accessible at www.dnr.wa.gov):

- USGS ShakeMap
- FEMA Loss Estimation (HAZUS) Report
- USGS Community Vulnerability Information
- Scenario Fact Sheet (EMD, USGS, FEMA, NOAA)

Washington State Earthquake Scenario Catalog: Impacts Viewer for Planning, Preparedness, Mitigation, & Response



US DOE BPA COVINGTON SUBSTAT, KENT

y of no damage - 0.32
f slight damage - 0.43
derate damage - 0.22
ensive damage - 0.03
nplete damage - 0.00

Pacific County Vulnerability, by Shaking Intensity

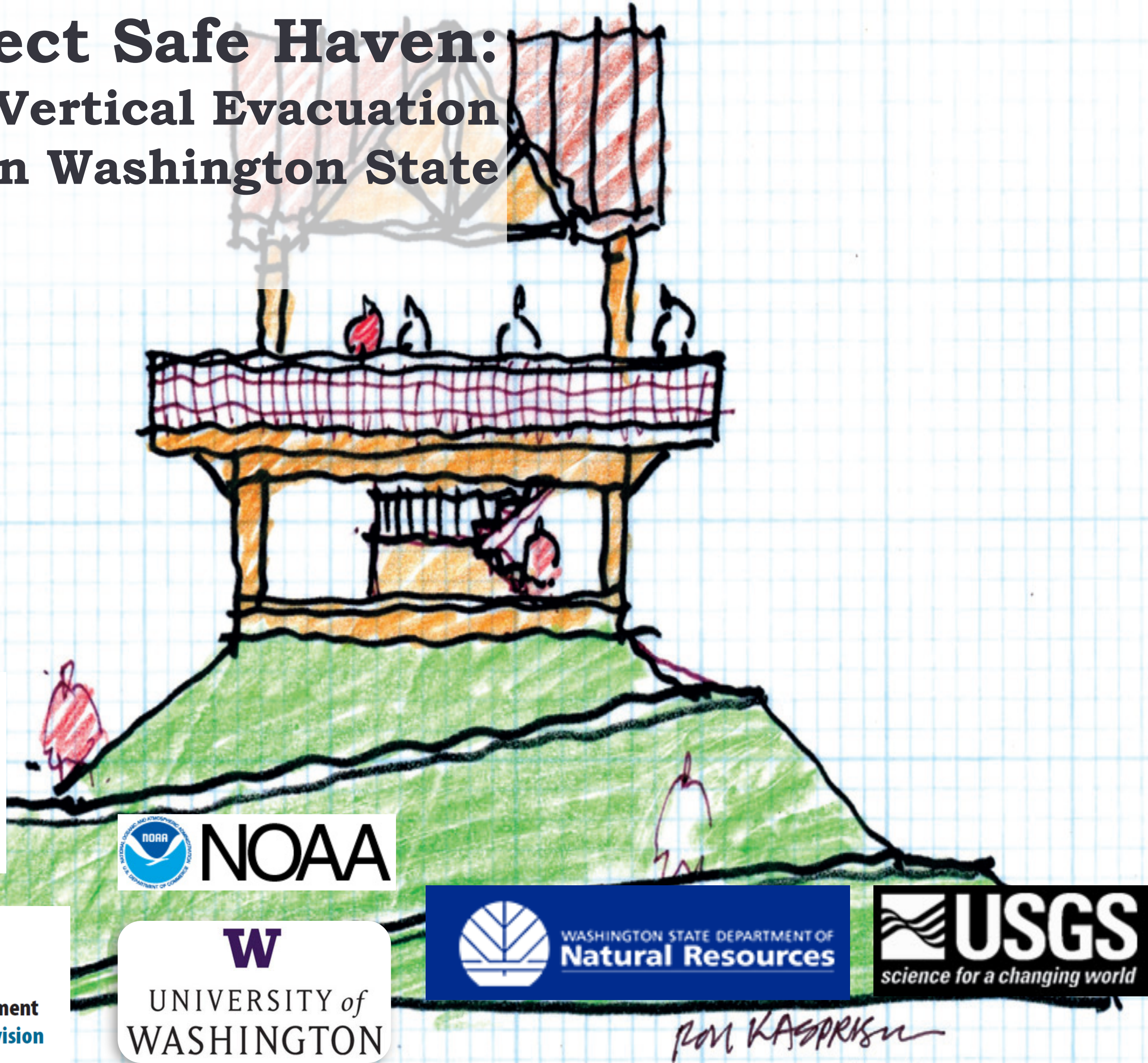
VERY STRONG SHAKING (MMI 7)

Total population - 2,522
Occupied housing units - 1,026
Number of businesses - 65
Number of employees - 511

SEVERE SHAKING (MMI 8,9)

Total population - 18,462
Occupied housing units - 8,070
Number of businesses - 439
Number of employees - 2,306

Project Safe Haven:
Tsunami Vertical Evacuation in Washington State



National Tsunami Hazard Mitigation Program

NOAA

Washington State Department of Natural Resources

USGS
science for a changing world

Washington Military Department
Emergency Management Division

University of Washington

Vertical Evacuation Safe Haven Project

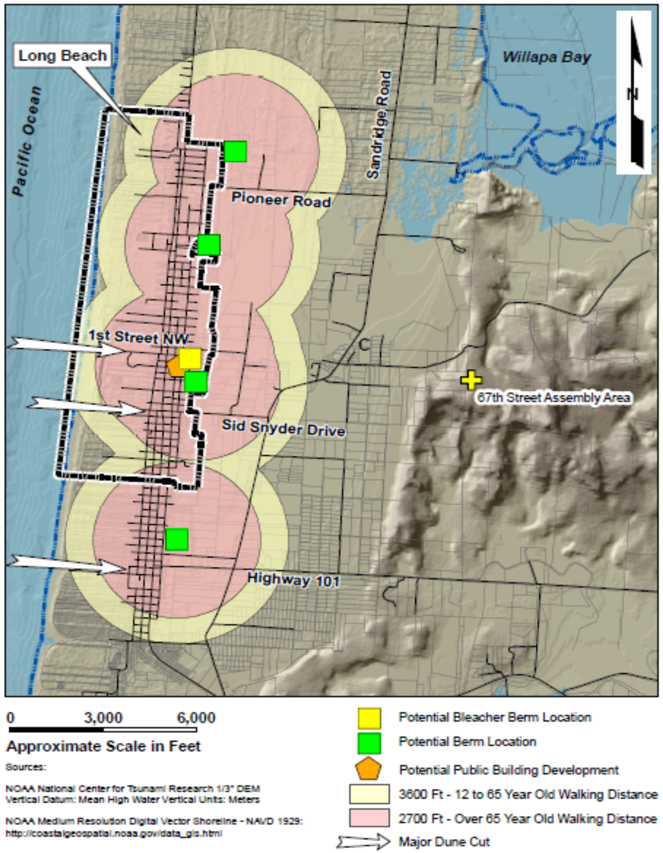
- Community-based, ‘bottom-up’ approach

- All options (buildings, towers, berms, etc.) are on the table for consideration

Common Themes:

- School Safety
- Seniors and special needs populations
- More conservative travel times

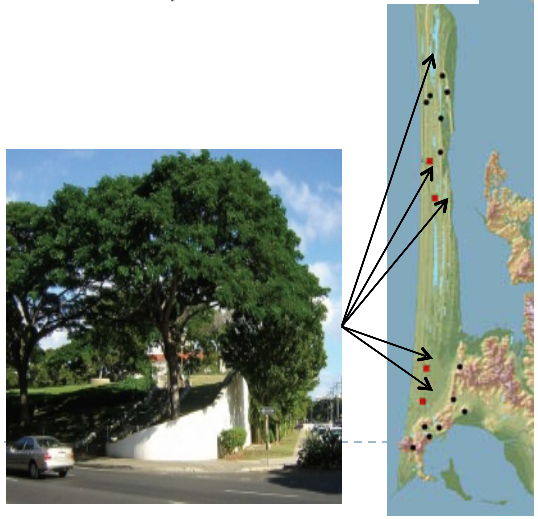
Figure 2 - Preferred Strategy


Long Beach
Pacific Ocean
Willapa Bay
N
Sandridge Road
Pioneer Road
1st Street NW
Sid Snyder Drive
67th Street Assembly Area
Highway 101
0
3,000
6,000
Approximate Scale in Feet
🟨 Potential Bleacher Berm Location
🟩 Potential Berm Location
⬟ Potential Public Building Development
3600 Ft - 12 to 65 Year Old Walking Distance
2700 Ft - Over 65 Year Old Walking Distance
⇨ Major Dune Cut

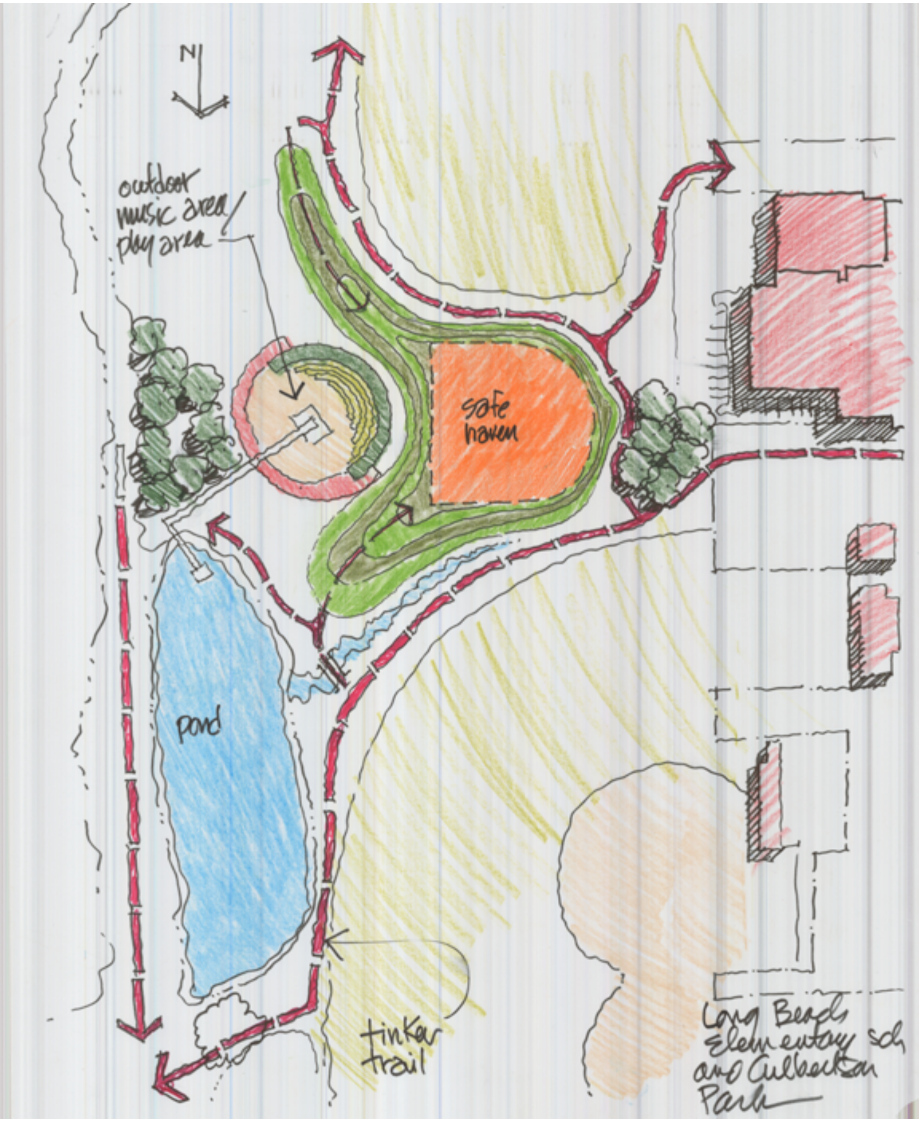
Sources:

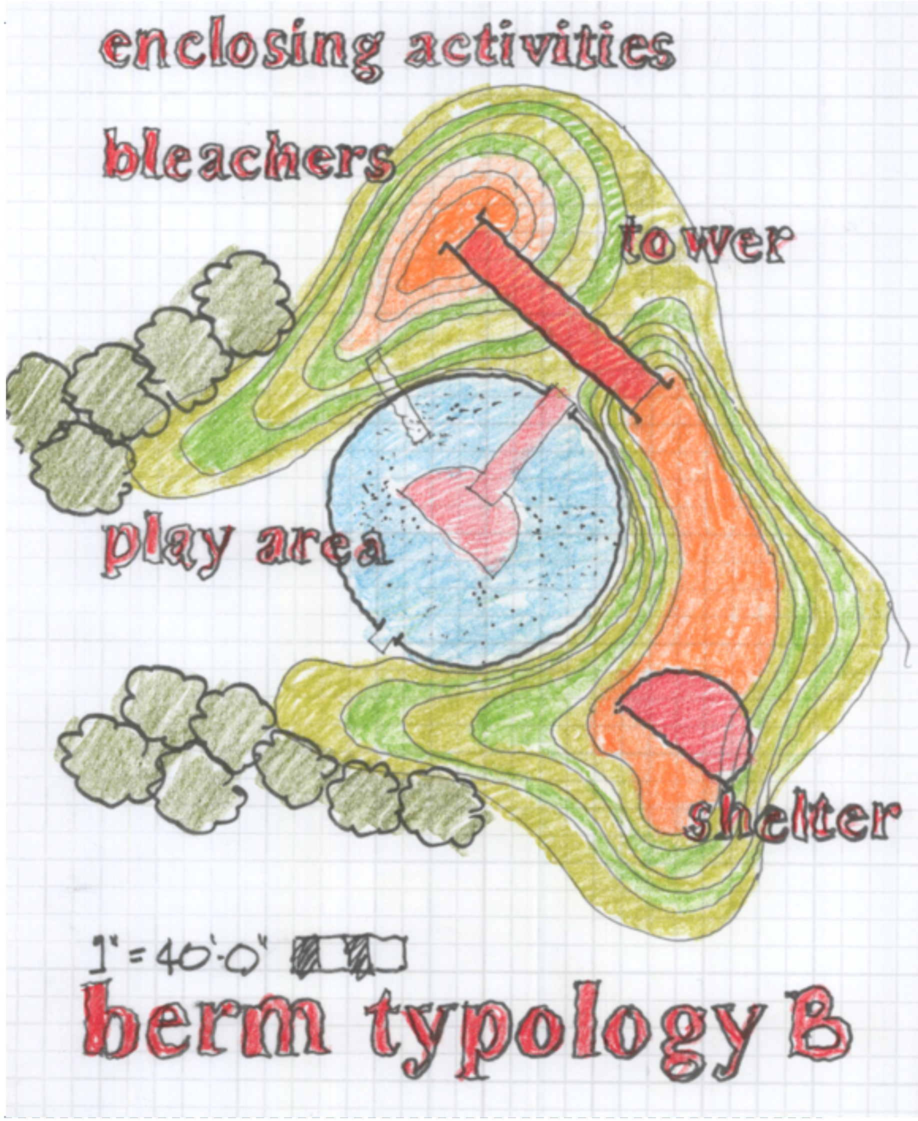
NOAA National Center for Tsunami Research 1/3" DEM
Vertical Datum: Mean High Water Vertical Units: Meters

NOAA Medium Resolution Digital Vector Shoreline - NAVD 1929:
http://coastalgeospatial.noaa.gov/data_gis.html

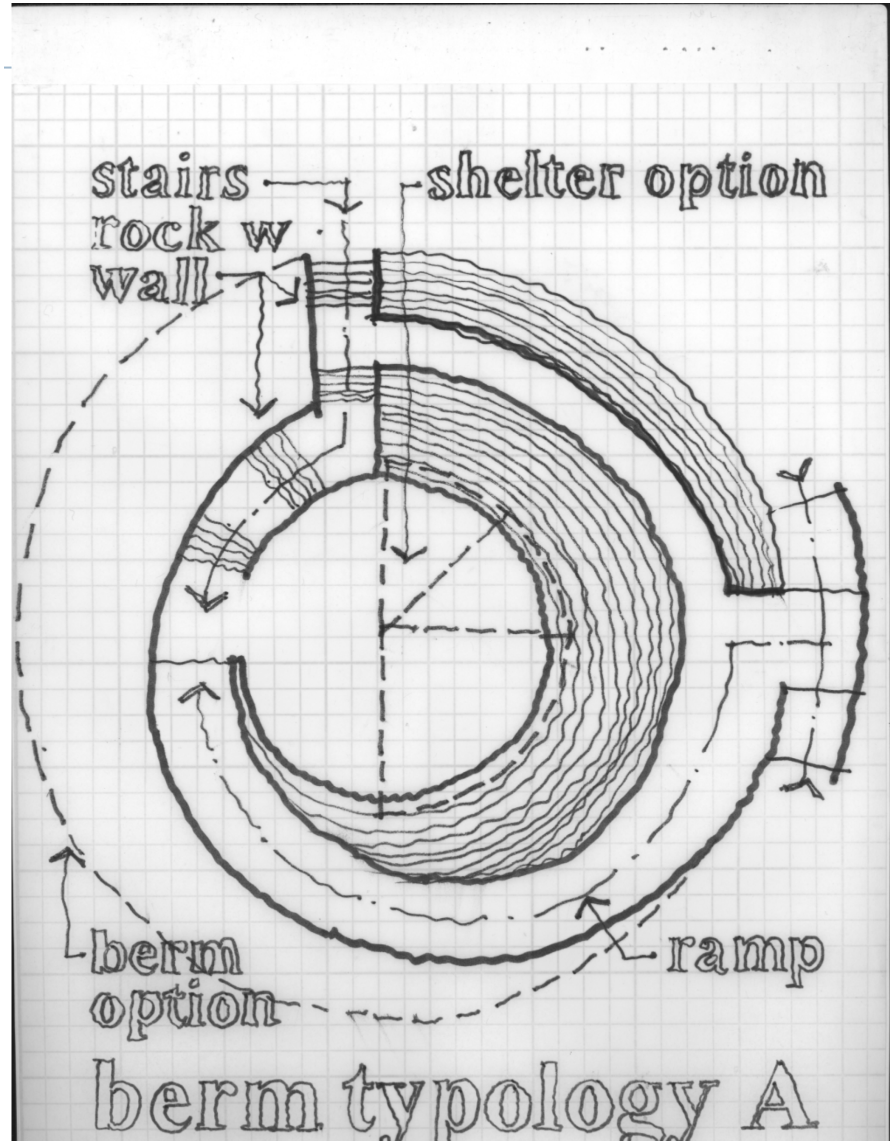


Safe Haven Berms

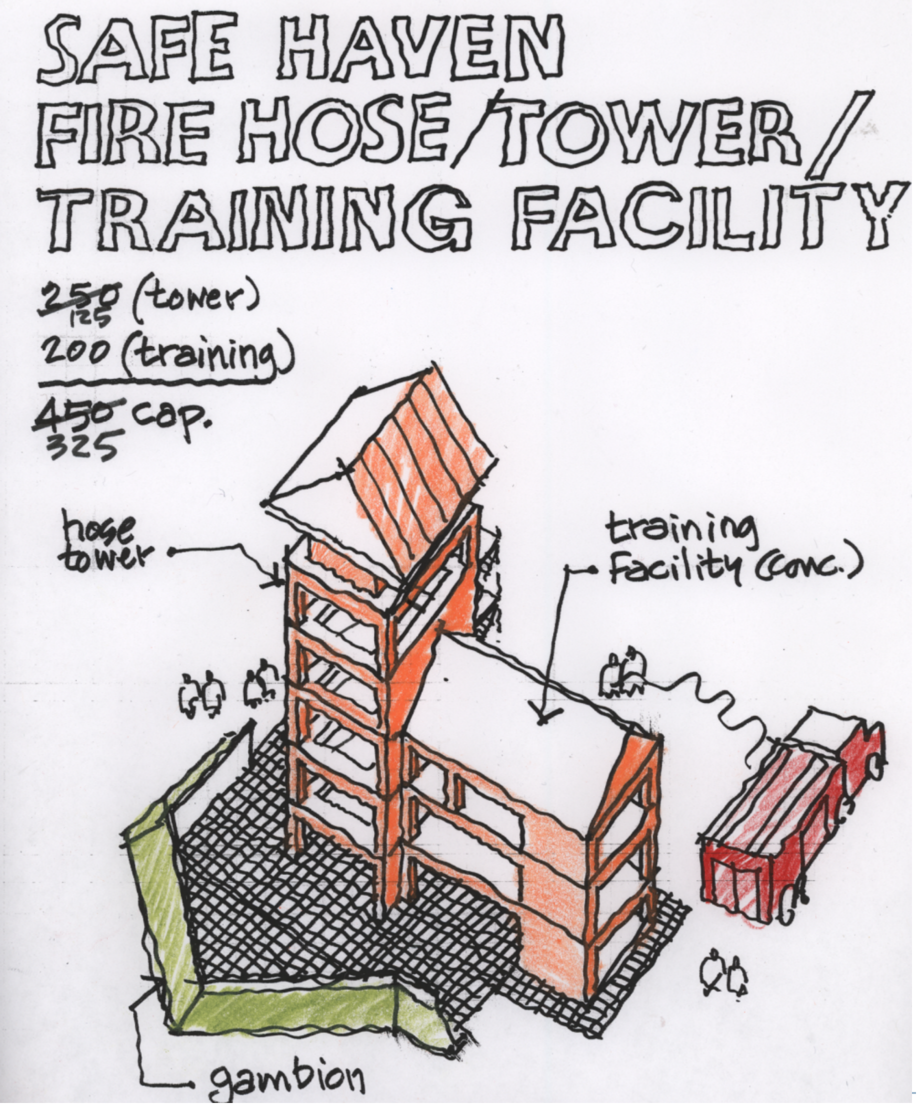

N
outdoor music area/ play area
safe haven
pond
tinker trail
Long Beach Elementary sch and Culbertson Park

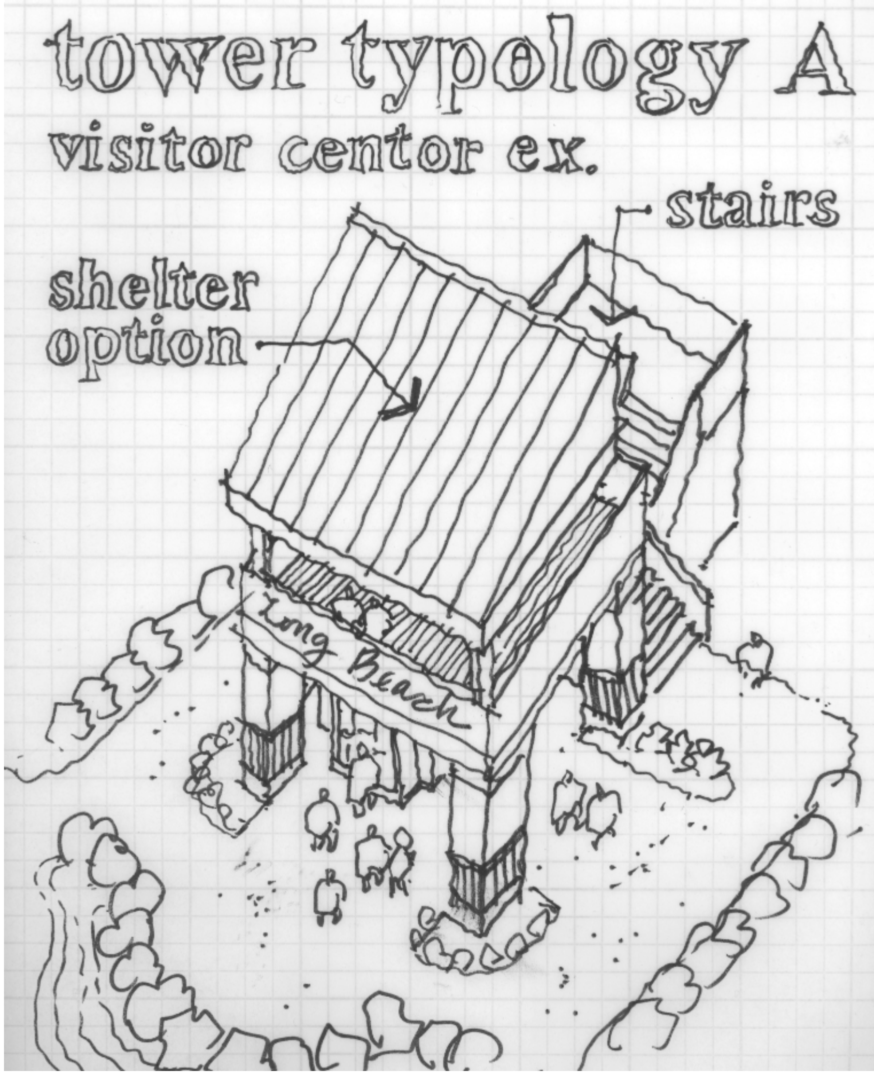


Safe Haven Berms

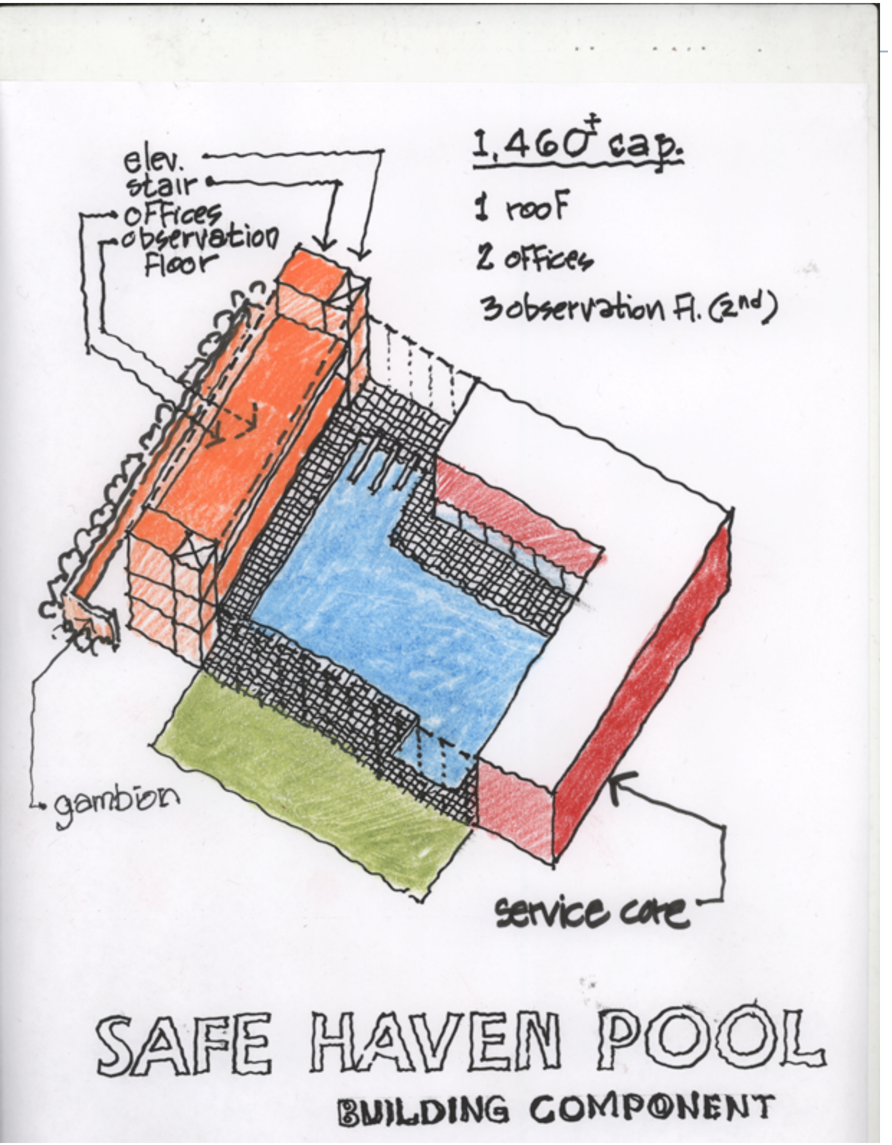


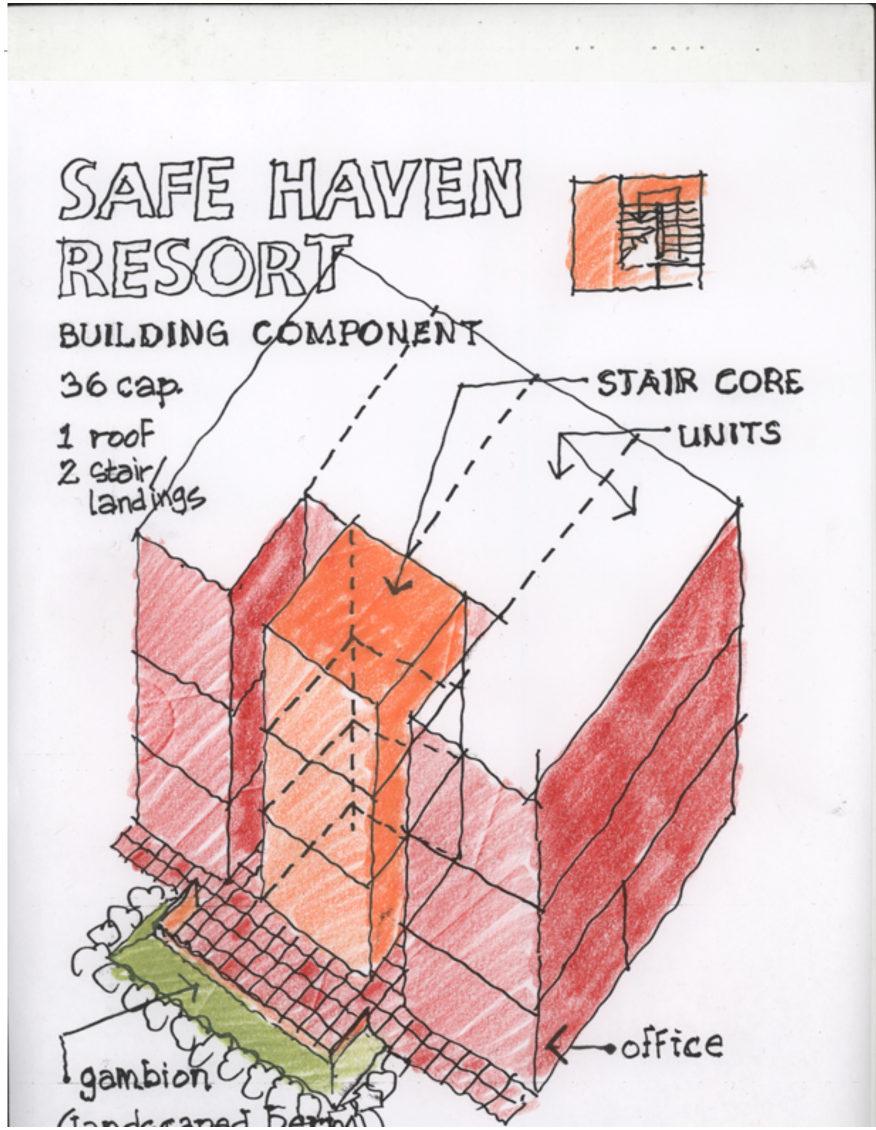
Safe Haven Towers

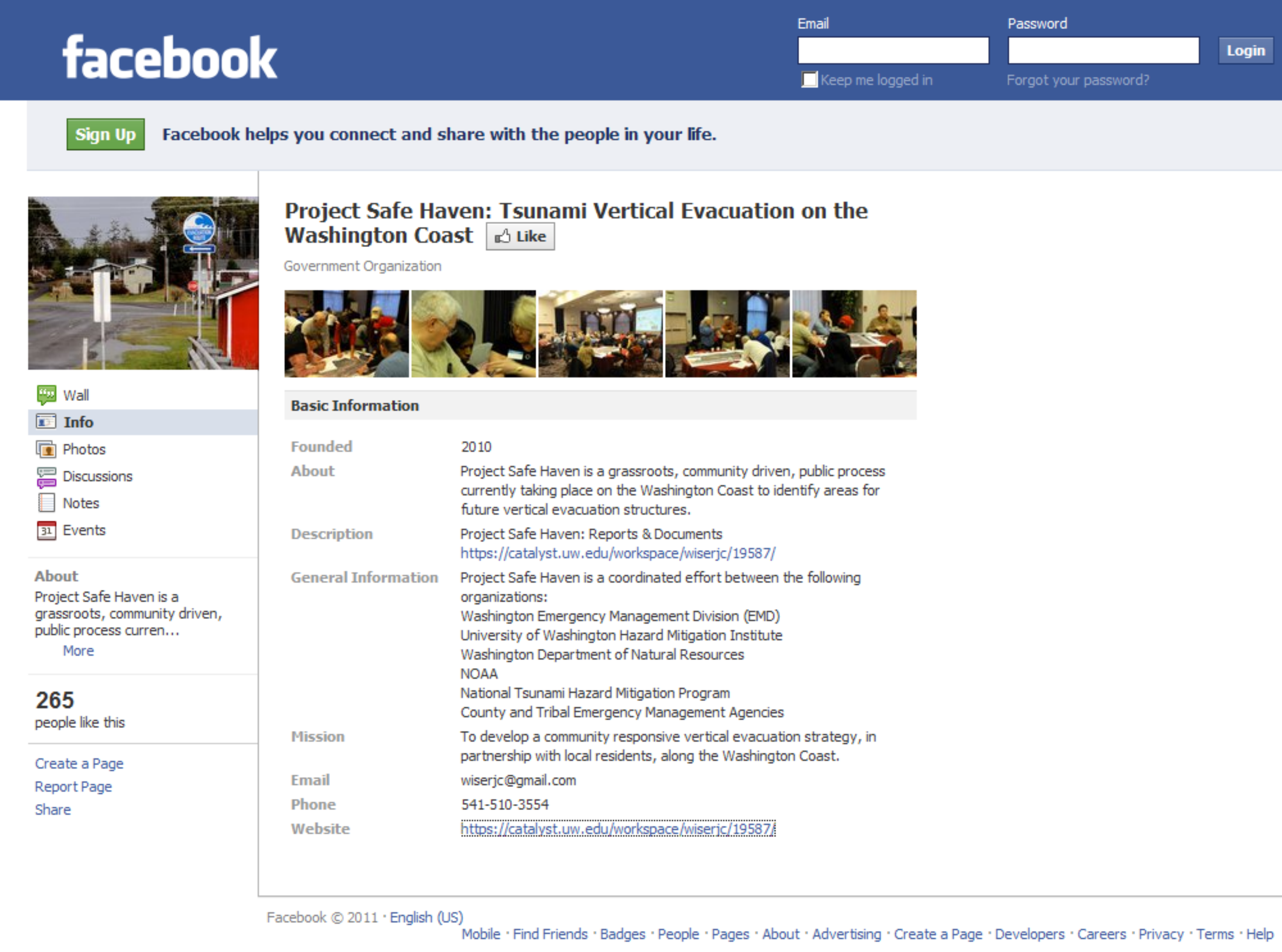




Safe Haven Buildings







Facebook helps you connect and share with the people in your life.

Project Safe Haven: Tsunami Vertical Evacuation on the Washington Coast

Government Organization

Basic Information

Founded	2010
About	Project Safe Haven is a grassroots, community driven, public process currently taking place on the Washington Coast to identify areas for future vertical evacuation structures.
Description	Project Safe Haven: Reports & Documents https://catalyst.uw.edu/workspace/wiserjc/19587/
General Information	Project Safe Haven is a coordinated effort between the following organizations: Washington Emergency Management Division (EMD) University of Washington Hazard Mitigation Institute Washington Department of Natural Resources NOAA National Tsunami Hazard Mitigation Program County and Tribal Emergency Management Agencies
Mission	To develop a community responsive vertical evacuation strategy, in partnership with local residents, along the Washington Coast.
Email	wiserjc@gmail.com
Phone	541-510-3554
Website	https://catalyst.uw.edu/workspace/wiserjc/19587/

About

Project Safe Haven is a grassroots, community driven, public process curren...

265
people like this

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Winner of Nine Pulitzer Prizes

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Originally published October 15, 2013 at 8:49 PM | Page modified October 16, 2013 at 6:04 AM

Grays Harbor County school to build first U.S. vertical-tsunami refuge

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Recommend 0
Comments (8)
E-mail article
Print

A new scenario for a Cascadia megaquake and tsunami warns that more than 10,000 could be killed and 30,000 injured. But a school district near Westport, Grays Harbor County, is doing everything it can to keep its students safe.

By Sandi Doughton
Seattle Times science reporter

A new scenario for a megaquake and tsunami off the Washington coast warns that the death toll could top 10,000 — but Paula Akerlund is doing everything she can to keep her kids safe. All 700 of them.

The Grays Harbor County school district Akerlund oversees on the Washington coast is preparing to build the nation's first tsunami refuge.

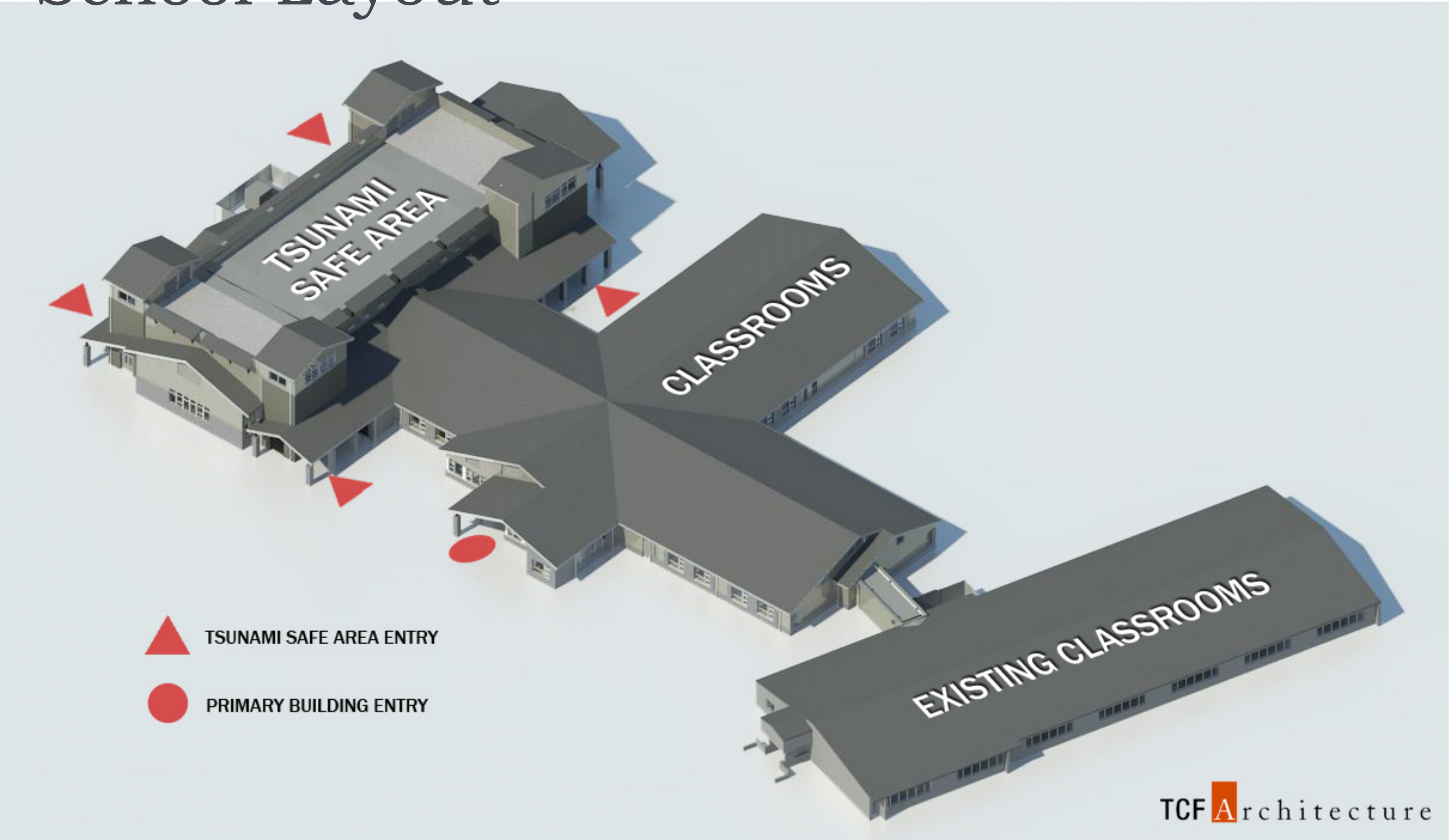
◄ PREV 1 of 2 NEXT ►

MIKE COVERDALE / SPECIAL TO THE SEATTLE TIMES

Design Charrette

- Incorporate refuge into elementary school
  - 25’ safe refuge elevation (50’ above MHW)
  - 700 students/faculty/staff
  - 1000 “total” capacity
- Access & Egress
  - Security & 24/7 access
  - Stairs
  - Shelter & supplies
- Structural system
- Budget impact

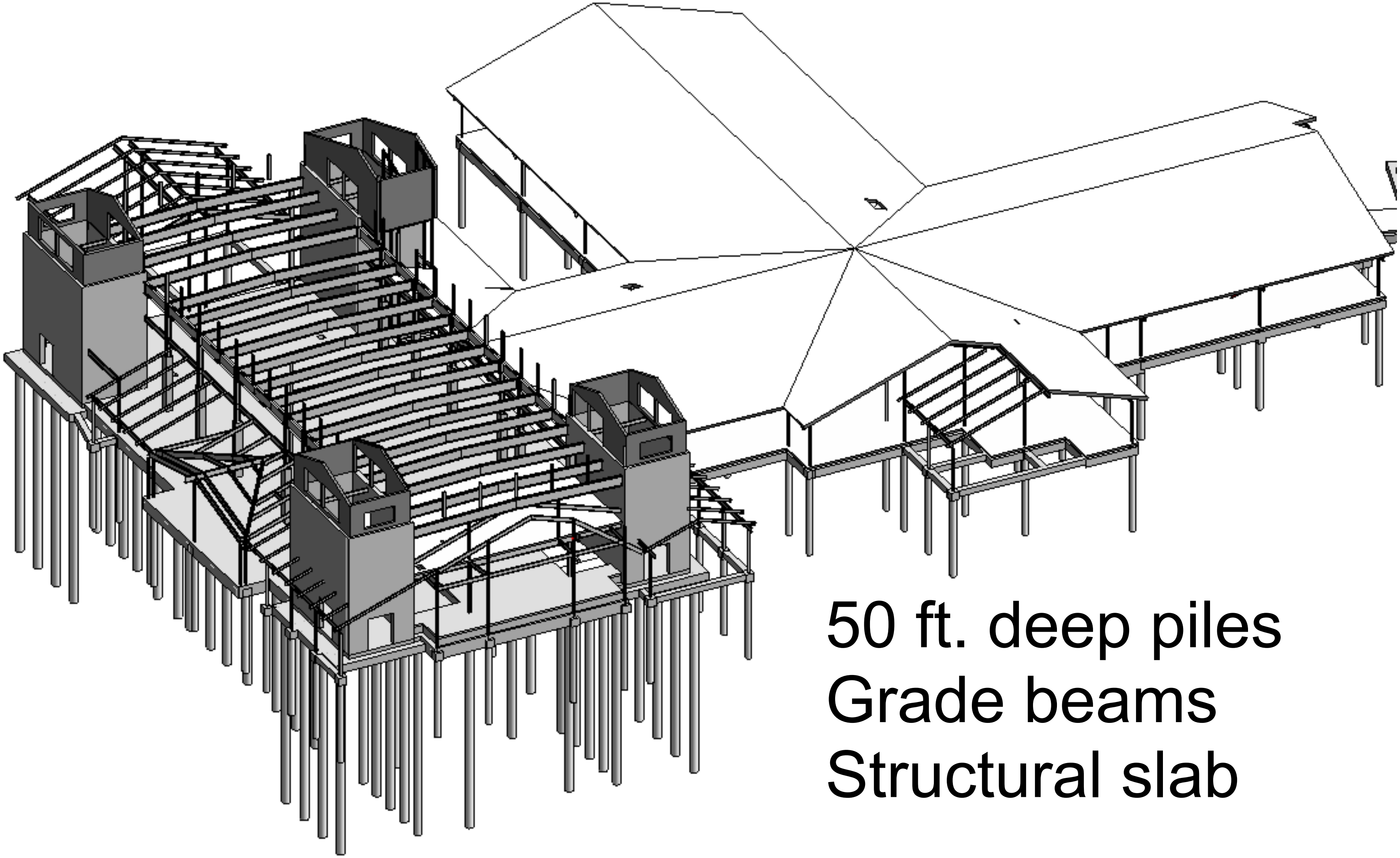
School Layout



Foundation Design

- Overturning
  - Buoyancy
  - Hydrodynamic
- Scour
  - Depth = 12 ft
- Liquefaction

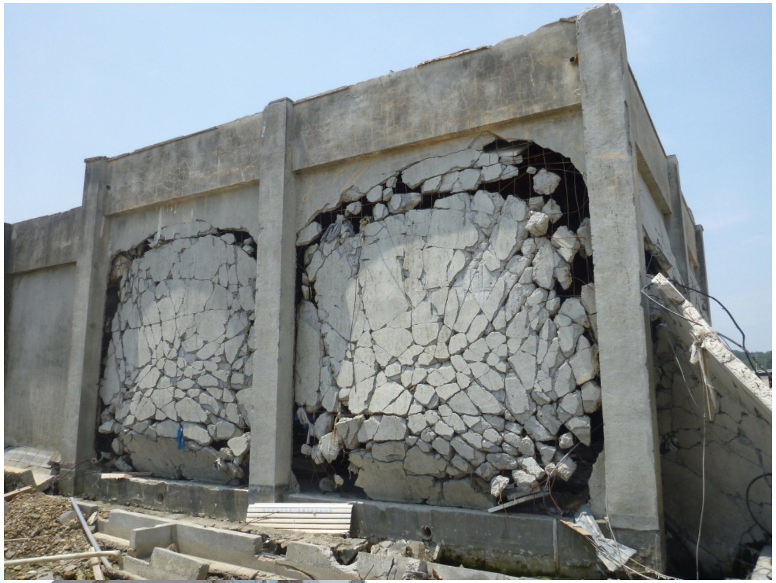
Foundation Design

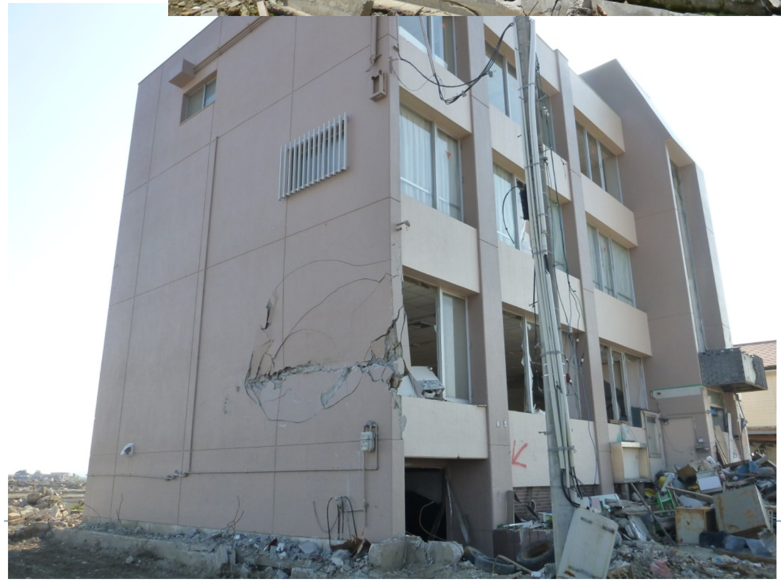


50 ft. deep piles
Grade beams
Structural slab

Structural Design

- Hydrostatic
- Hydrodynamic
- Impact
  - Logs
  - Vehicles
- Progressive collapse





Finished Design

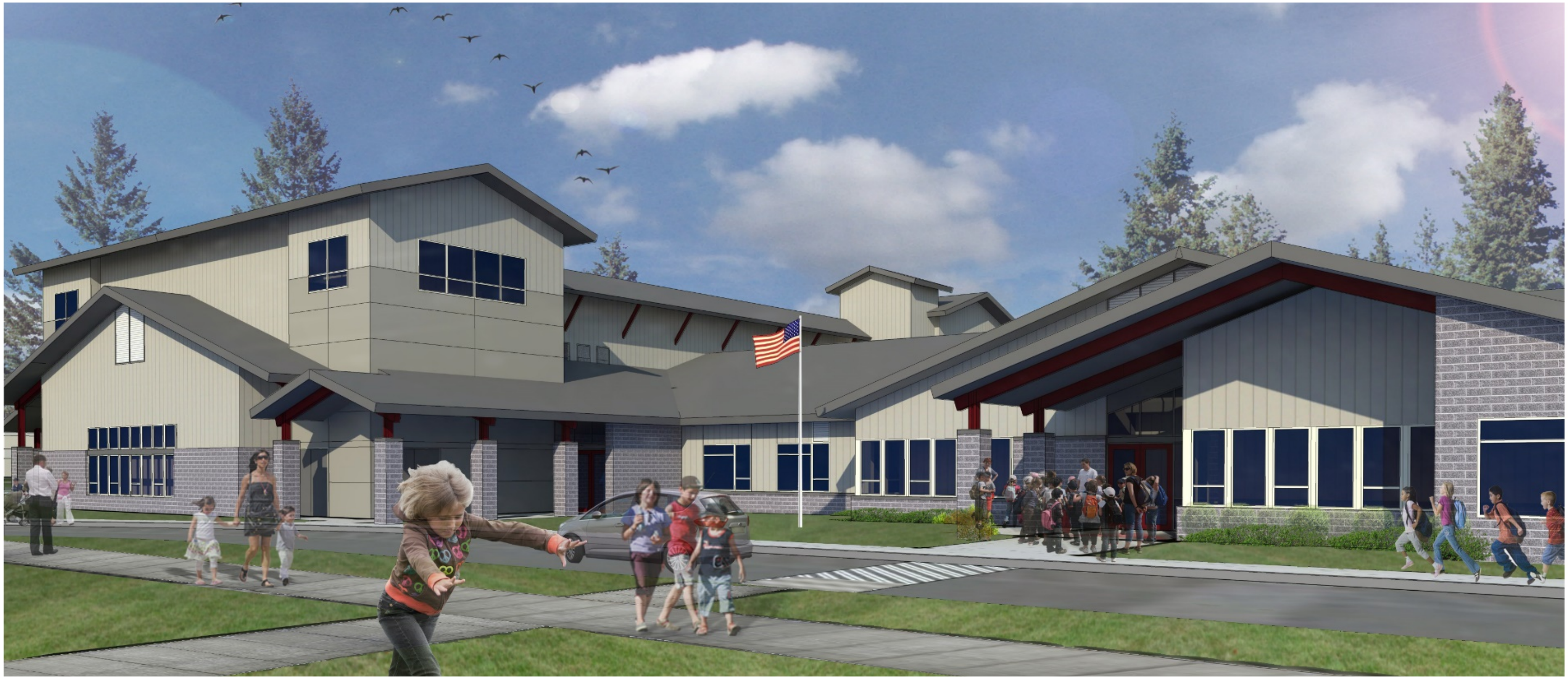


image courtesy TCF Architecture

Finished Design

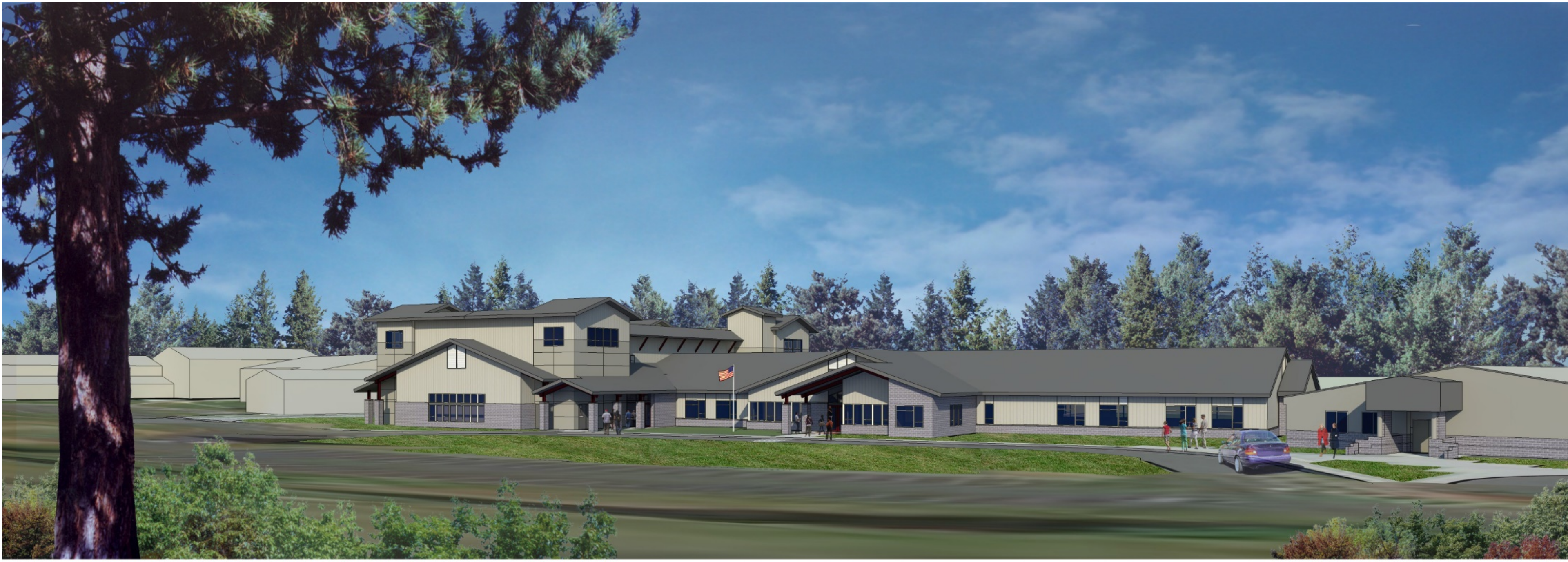


image courtesy TCF Architecture

Finished Design

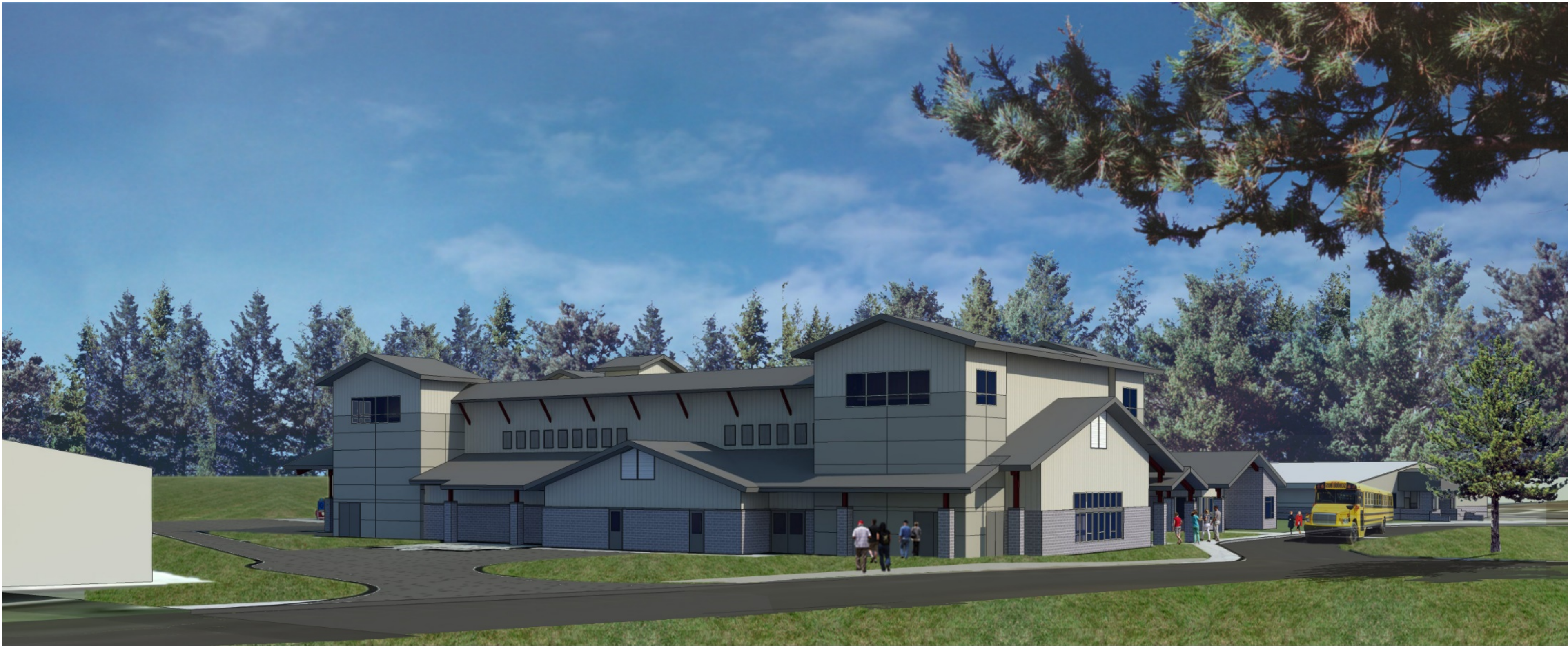


image courtesy TCF Architecture

Tsunami Education = Lives Saved

“Children at the school had received tsunami training the Friday before the tsunami. When the teachers felt the quake, they led the children out the back of the school and up the hill”

“It saved the school,”

“Thank God those teachers knew what they were doing.”

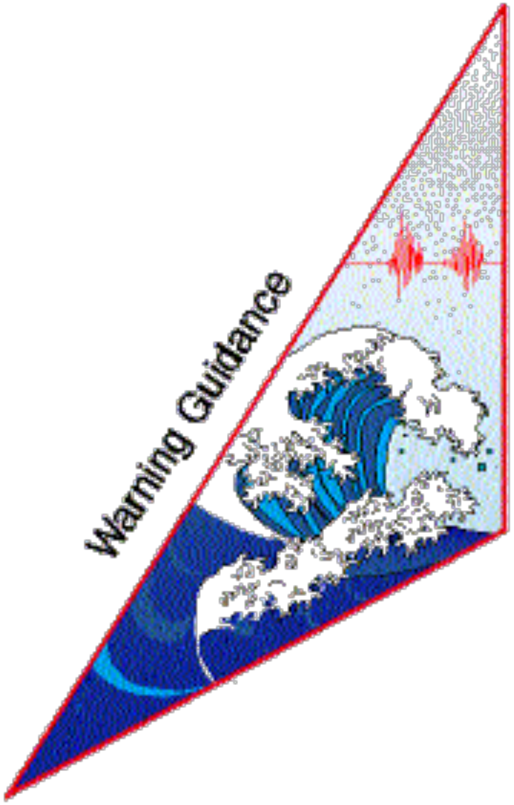
- Peter Gurr of Maota, Samoa

Source: Kamaichi city

“The pre-disaster education guided the pupils at primary and junior high schools in Ishinomaki-city (one of the cities completely washed away) to safety during the tsunami. Miszuhama area in Ishinomaki has a total of 380 residents and about 130 households. However, only one person died and eight remain missing. It has been revealed that ***the people’s awareness of what do do at the event of an earthquake and regular conduct of (tsunami evacuation) exercises/drill had helped them***”

-Mr A. Koresawa, Asian Disaster Reduction Center
-Dr. Y. Kawaki, International Recovery Platform

Warning Guidance



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State tsunami programs in collaboration with federal, state, and local officials develop warning and response protocols:

- ➢NOAA:
  - Tsunami Detection
  - Tsunami Bulletin Issuance
- ➢State & Local Warning Points
  - Alert and Notification
  - Evacuation Orders

Warning System Advancements

NOAA Tsunami "DART" Buoy

National Tsunami Warning Center – Palmer, Alaska

- In 2004, there were 6 dart buoys.
- In 2014, there were 60.

- In 2004, not every school, hospital, etc. had a NOAA Weather Radio
- In 2014, all Pacific Ocean & Strait of Juan de Fuca had one installed.

Warning Systems & Protocols

State tsunami programs help ensure coordinated alert messages between Federal-to-State & State-to-Local warning points

Assist in the development of warning protocols , exercises, & training for:

EAS
Emergency Alert System

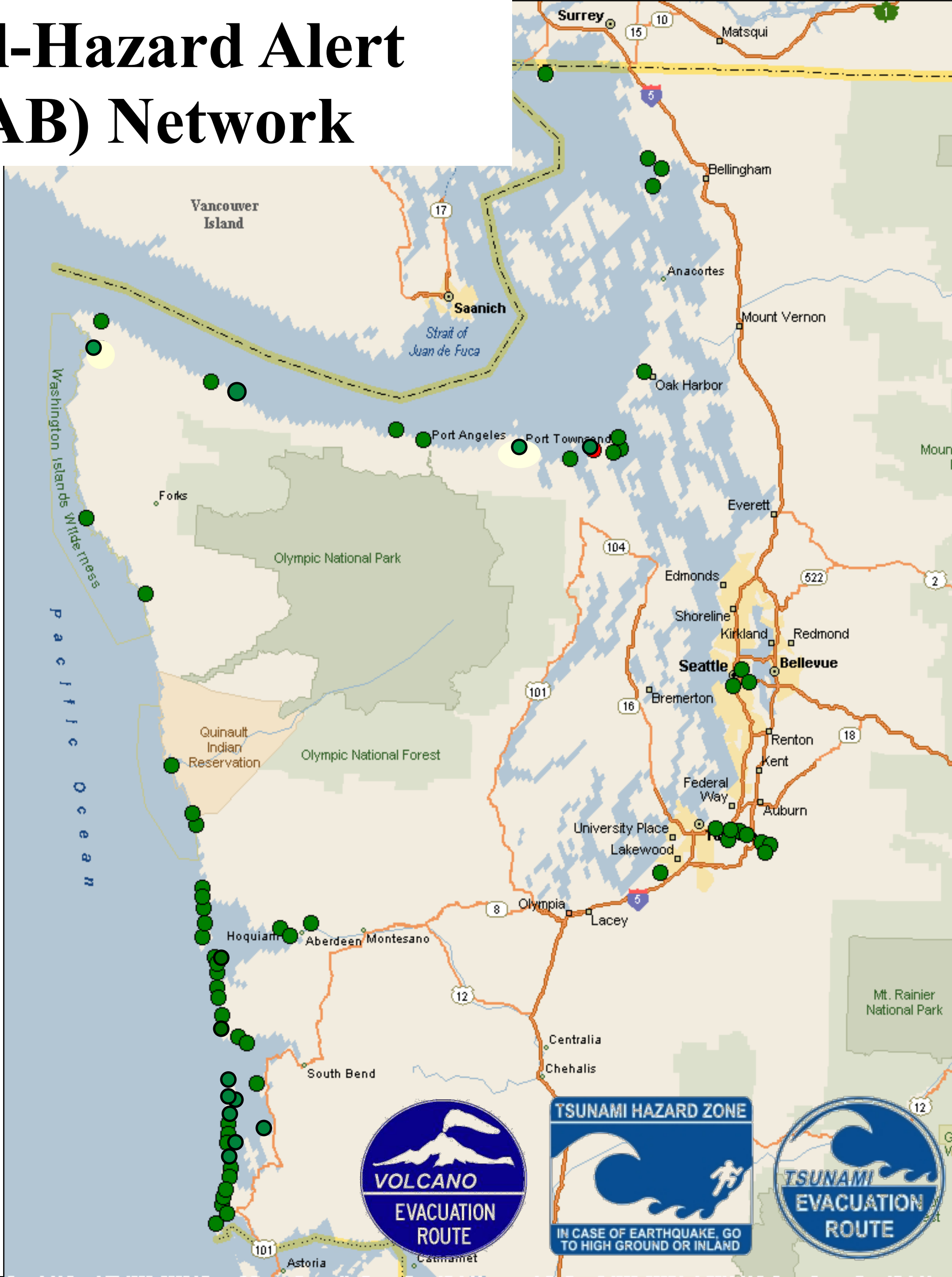
- ➢ Outdoor Notification Siren Systems
- ➢ Emergency Alert System (EAS)
- ➢ NOAA Weather Radios
- ➢ Outdoor Loudspeakers

NOAA
Weather Radio
Emergency Information Network

Washington State All-Hazard Alert Broadcasting (AHAB) Network

OPERATIONAL (58)

- Aberdeen (2)
- Bay Center
- Cape Disappointment
- Clallam Bay
- Copalis Beach
- Cohasset Beach
- Diamond Point
- Dungeness Spit
- Fort Worden
- Grayland (4)
- Hoh Tribe
- Hoquiam
- Ilwaco
- Oak Harbor
- La Push (Quileute Tribe)
- Long Beach (8)
- Lower Elwha
- Lummi Nation (2)
- North Cove
- McAlder
- McMillin
- Moclips
- Neah Bay
- Ocean City
- Ocean Park (4)
- Ocean Shores (4)
- Orting (3)
- Puyallup (2)
- Pacific Beach
- Pacific Park
- Point Roberts
- Port Angeles
- Port Townsend (2)
- Sandy Point
- Seattle (3)
- Seaview
- Sumner
- Surfside
- Taholah (Quinault Nation)
- Shoalwater Bay Tribe (2)
- Westport (4)
- Camp Murray (Controller)



96 AHABs are needed along the outer coast for tsunami warning

Current: 58 tsunami, 8 lahar

Not only has our understanding of the earth changed, but also our understanding of how people prepare and respond.

Effective Risk Communication

- Optimism Bias – It won't happen to me
  - The **optimism bias** (also known as **unrealistic** or **comparative optimism**) is a bias that causes a person to believe that they are less at risk of experiencing a negative event compared to others

- Scarring people doesn't work, empowering them does!

- Research by sociologists Dr. Linda Bourque of the UCLA School of Public Health and Dr. Dennis Mileti of the University of Colorado at Boulder, form the foundation for the current engagement – **development of an evidence-based standardized message, to be delivered in a consistent manner over multiple channels, over a long period of time, via a coordinated campaign among the various local, state and federal programs and agencies engaged in earthquake preparedness.**

Effective Risk Communication

- Information should tell people what they need to do, not just discuss the threat.

- Messages should communicate why it matters to become prepared and what people will get out of it.

- Encourage people to talk more about their readiness actions and behavior, and to share what they have done.

- To be effective, any campaign needs to be implemented over the long haul. Success will not happen with a one-shot, short-term effort.

- Among the most important recommendations made by Dr. Mileti is to **"brand the message"** and not the messenger, which the steps above will accomplish.

We keep telling people the same thing, but why don't they just prepare already?!?!

- **People have logical reasons for their decisions, but they are also trying to satisfy deeper personal, emotional needs and values.**
- **Values are the ultimate roots from which behavior originates and what people are attempting to satisfy when they make life choice decisions.**
- Roughly 25 "terminal values" have been identified in the literature.

Terminal Values

Self-Esteem	Belonging
Personal Satisfaction	Trust
Sense of Accomplishment	Sharing with others
Security	Self-Fulfillment
Care for Others	Sanctity of Life
Peace of Mind	Pride
Enjoyment/Enjoy Life	Love
Happiness	Self-Preservation
Personal Freedom and Control	Preserve the Earth
Take Care of Family	Eternal Life/God
Longevity	Resect
Concern for Future Generations	Self-Image

Messaging - From Theory to Practice

- The challenge is in understanding the mental pathways people follow between choices in a given decision and the values that are most important to them.
- Once the most dominant pathways to decision-making have been uncovered, powerful strategies can be developed to tap into those pathways. Each pathway in the resulting framework will include attributes, functional consequences, emotional consequences, and personal values, as defined below.

- **Attributes** are the facts and issue characteristics that people think about a product or issue, using preparedness as an example –
  - *Having a box in their house with 2 to 3 days of snacks or water* – may be an action people take.
- **Functional consequences** are the rational implications of the attributes, elicited by asking what the benefit is to having 2-3 days of water and snacks on hand –
  - *It means family members will have food and water for a few days.*
- At the **emotional consequence** level, the decision-making process becomes personally relevant, focusing on what about the functional consequence matters to the individual –
  - *I will be able to take care of my family for the first few days after an earthquake.*
- Finally, the **values** level of the pathway addresses the enduring personally relevant needs that make a choice important –
  - *It gives me peace of mind that I have done what I could.*

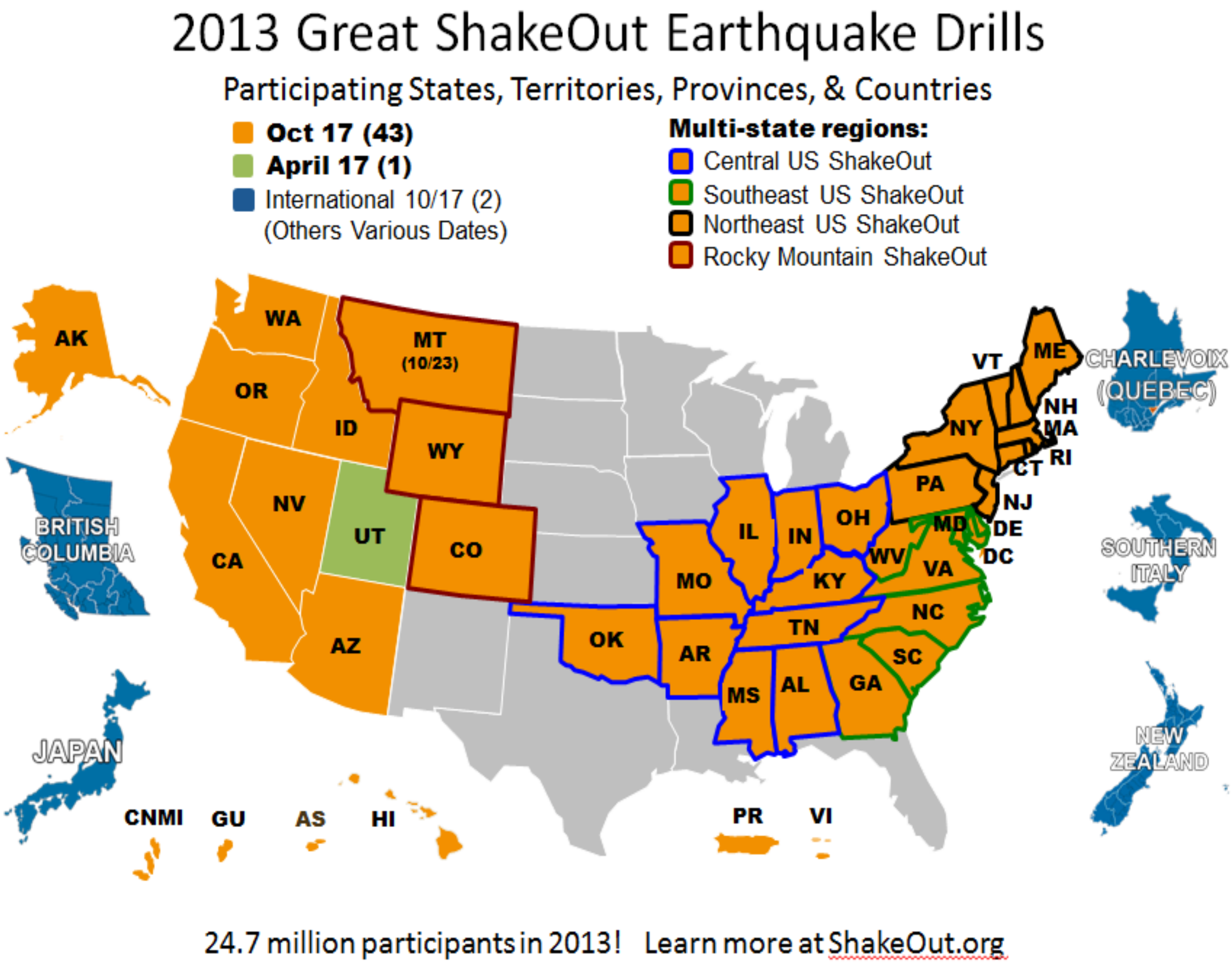
Recommendations for Successful Messaging

- Talk about why preparedness is important to do (the emotional and value level), not just what they should do (attribute and functional consequence level).
- Every communication should connect the attribute (i.e., kit, disaster plan, etc) with the value associated with it (i.e., peace of mind, confidence).
- Emotions and values can and should be communicated using both words and images.
- Avoid using guilt as the emotional pull of communications. This puts people on a negative and self-defeating pathway that will take away their self-esteem and will lead them to the idea that preparation is futile and can't be done.

Recommendations for Successful Messaging

- Communicate often using a variety of mediums; short term or one-off campaigns will likely not produce the desired result.
- Communicate in a consistent manner. The emotions and values identified here will apply to the short and long terms aspects of earthquake preparedness so it's important to have that guide communications.
- The emotional and value level findings are true across demographic groups, regardless of age, race/ethnicity or where one lives in Washington (i.e. more risky or less risky area).

Effective Branding of Seismic Safety: Great ShakeOut Earthquake Safety Drills



2013 Great ShakeOut Earthquake Drills

Participating States, Territories, Provinces, & Countries

🟧 **Oct 17 (43)**
🟩 **April 17 (1)**
🟦 International 10/17 (2)
(Others Various Dates)

Multi-state regions:
Central US ShakeOut
Southeast US ShakeOut
Northeast US ShakeOut
Rocky Mountain ShakeOut

24.7 million participants in 2013! Learn more at ShakeOut.org

2013 Official ShakeOut Regions

21 Regions (+5 from 2012)

44 U.S. States/ Territories (+20)

Total Registration

(worldwide)

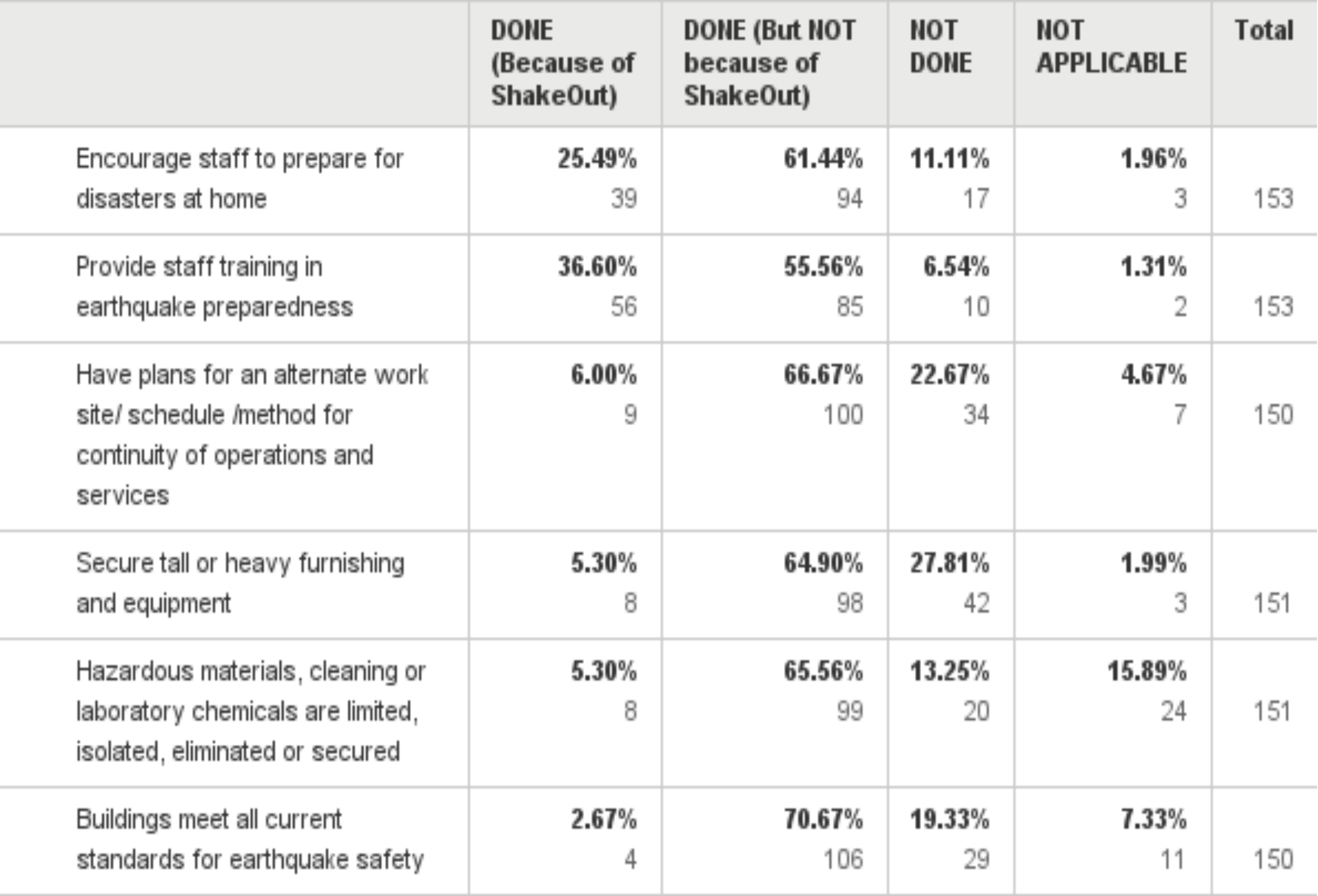
2013: *24.7 million*
2012: 19.5 million
2011: 12.5 million
2010: 8.0 million
2009: 6.9 million
2008 5.4 million

The Great Washington ShakeOut:

Drop, Cover, Hold Drill & Coastal Tsunami Warning Siren Test
October 18, 2012

Q37: Which things has your organization done to prepare for earthquakes? Did you do them ***because of ShakeOut***?

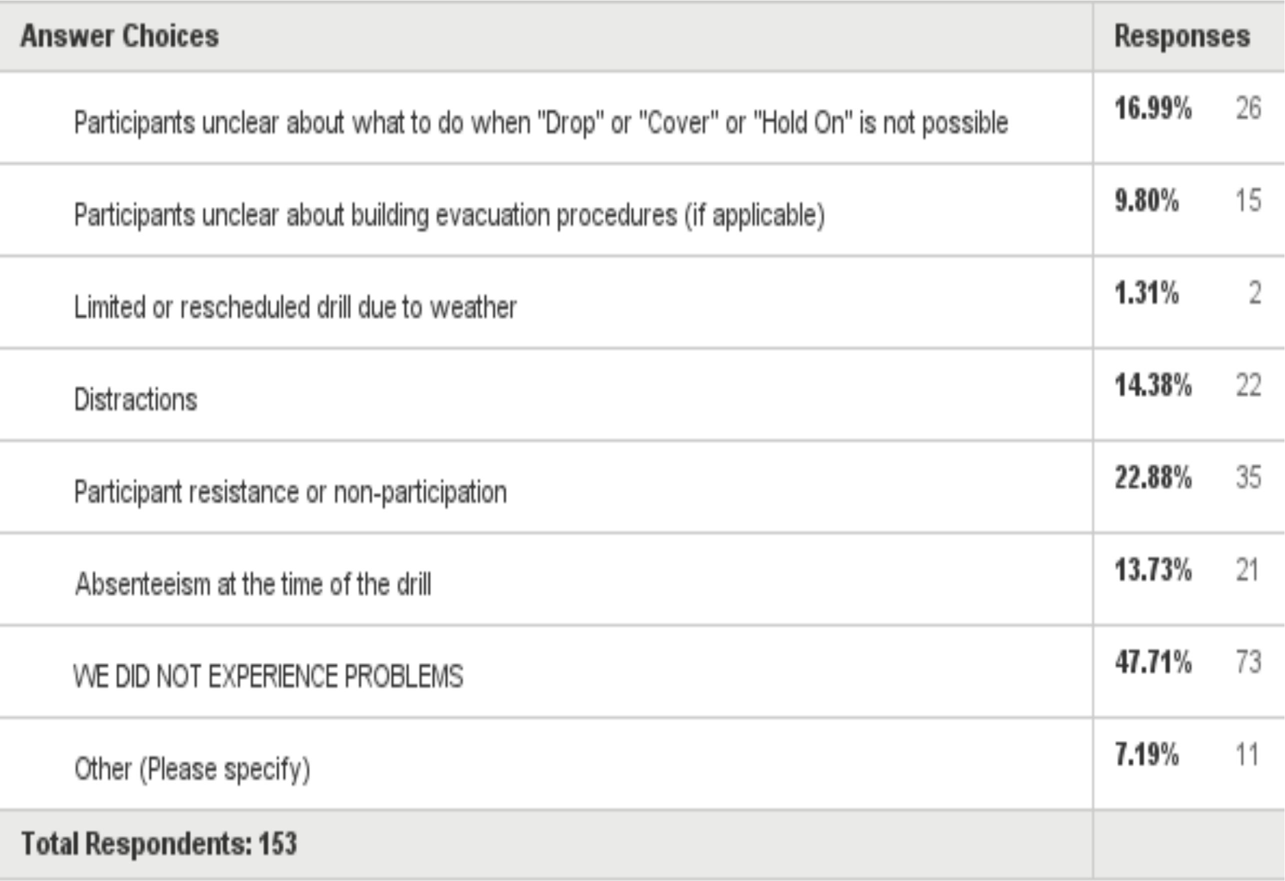
- Answered: 153 Skipped: 14



	DONE (Because of ShakeOut)	DONE (But NOT because of ShakeOut)	NOT DONE	NOT APPLICABLE	Total
Encourage staff to prepare for disasters at home	**25.49%** 39	**61.44%** 94	**11.11%** 17	**1.96%** 3	153
Provide staff training in earthquake preparedness	**36.60%** 56	**55.56%** 85	**6.54%** 10	**1.31%** 2	153
Have plans for an alternate work site/ schedule /method for continuity of operations and services	**6.00%** 9	**66.67%** 100	**22.67%** 34	**4.67%** 7	150
Secure tall or heavy furnishing and equipment	**5.30%** 8	**64.90%** 98	**27.81%** 42	**1.99%** 3	151
Hazardous materials, cleaning or laboratory chemicals are limited, isolated, eliminated or secured	**5.30%** 8	**65.56%** 99	**13.25%** 20	**15.89%** 24	151
Buildings meet all current standards for earthquake safety	**2.67%** 4	**70.67%** 106	**19.33%** 29	**7.33%** 11	150

Q32: We experienced the following **problems** with our drill: (Check all that apply)

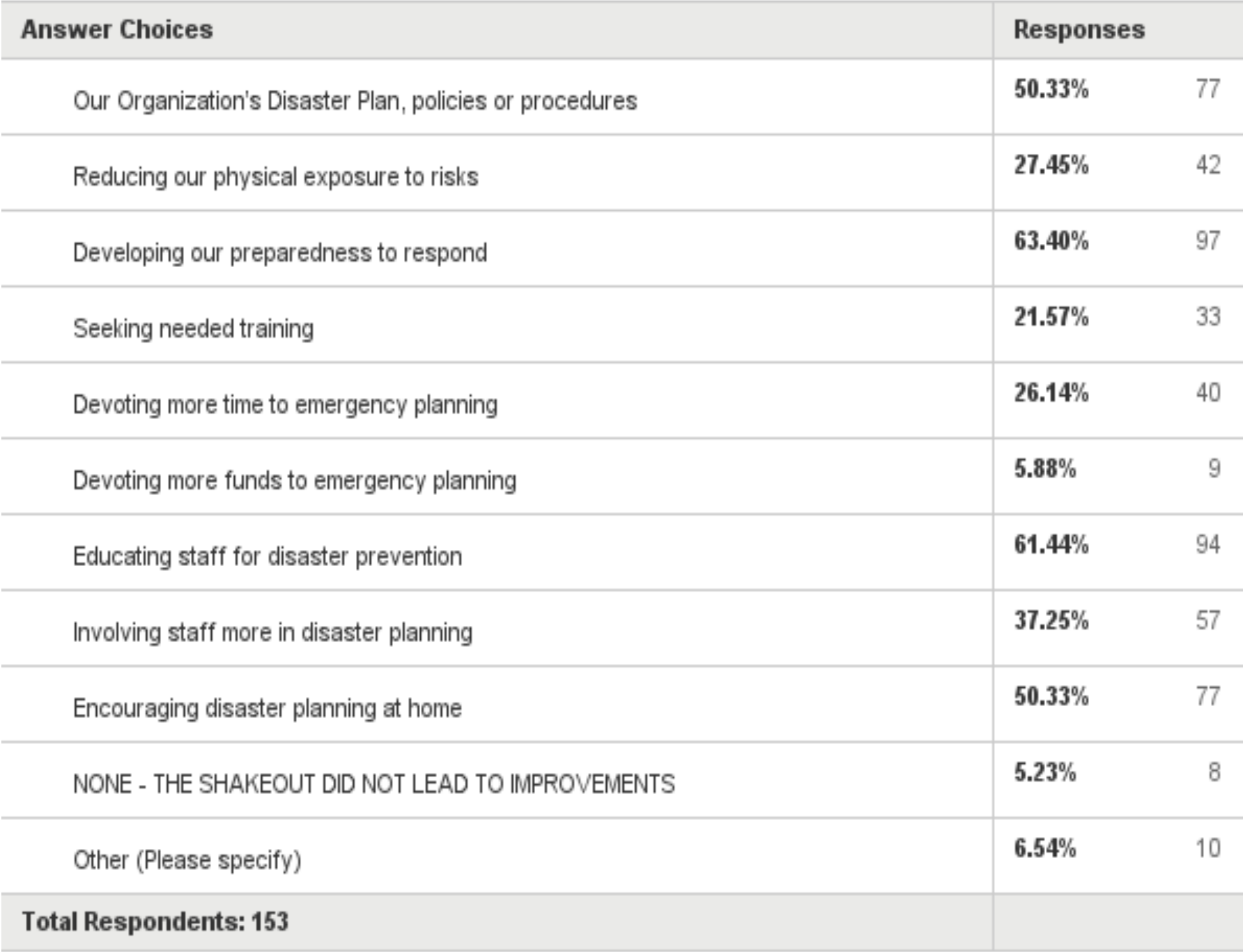
- Answered: 153 Skipped: 14



Answer Choices	Responses	
Participants unclear about what to do when "Drop" or "Cover" or "Hold On" is not possible	**16.99%**	26
Participants unclear about building evacuation procedures (if applicable)	**9.80%**	15
Limited or rescheduled drill due to weather	**1.31%**	2
Distractions	**14.38%**	22
Participant resistance or non-participation	**22.88%**	35
Absenteeism at the time of the drill	**13.73%**	21
WE DID NOT EXPERIENCE PROBLEMS	**47.71%**	73
Other (Please specify)	**7.19%**	11
Total Respondents: 153		

Q31: Our ShakeOut participation (up to and including this year) has led to **improvements** in the following areas (check all that apply):

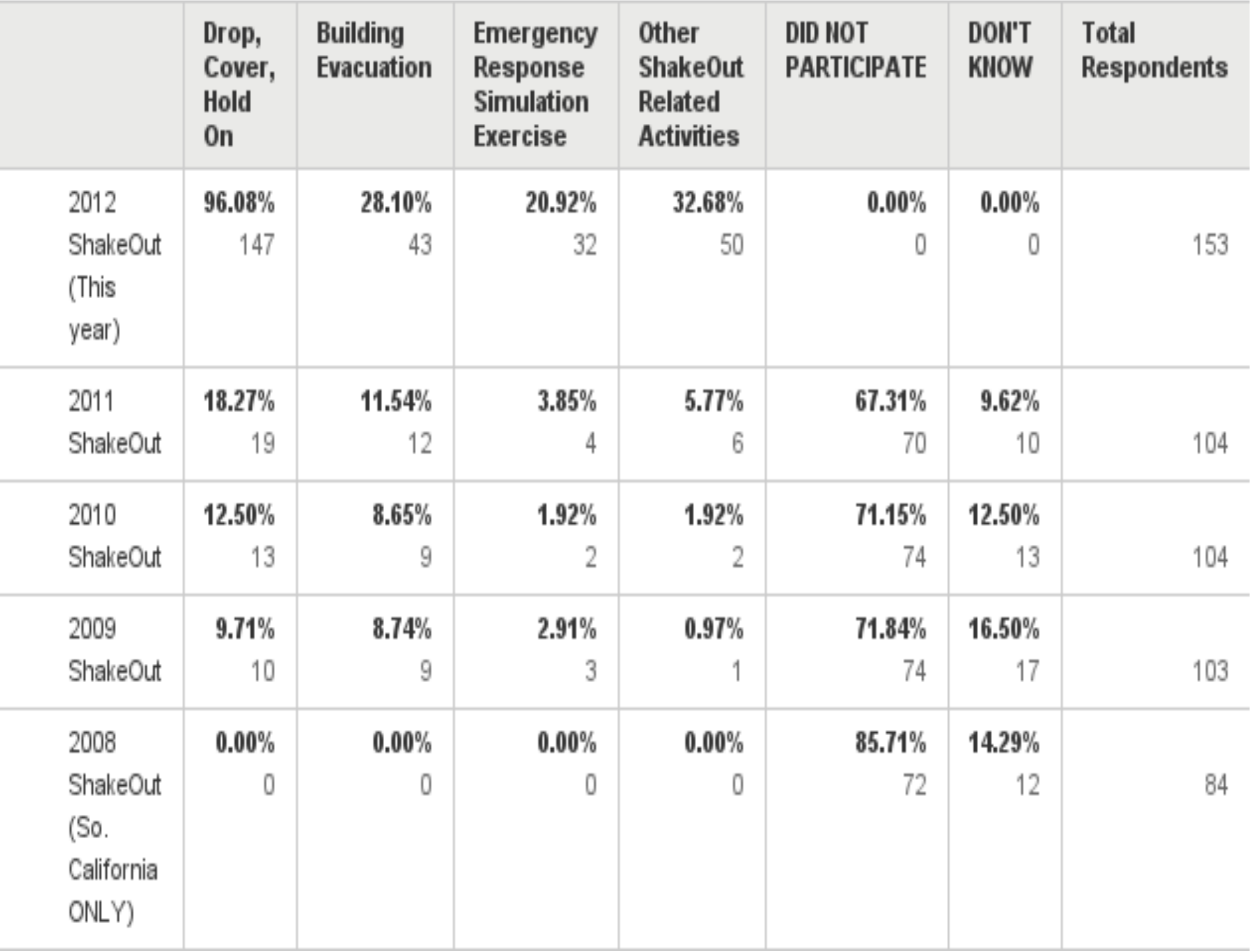
- Answered: 153 Skipped: 14



Answer Choices	Responses	
Our Organization's Disaster Plan, policies or procedures	**50.33%**	77
Reducing our physical exposure to risks	**27.45%**	42
Developing our preparedness to respond	**63.40%**	97
Seeking needed training	**21.57%**	33
Devoting more time to emergency planning	**26.14%**	40
Devoting more funds to emergency planning	**5.88%**	9
Educating staff for disaster prevention	**61.44%**	94
Involving staff more in disaster planning	**37.25%**	57
Encouraging disaster planning at home	**50.33%**	77
NONE - THE SHAKEOUT DID NOT LEAD TO IMPROVEMENTS	**5.23%**	8
Other (Please specify)	**6.54%**	10
Total Respondents: 153		

Q27: The organization that I am responding for participated in THIS AND PREVIOUS ShakeOut drills in the following ways (check all that apply):

- Answered: 153   Skipped: 14



	Drop, Cover, Hold On	Building Evacuation	Emergency Response Simulation Exercise	Other ShakeOut Related Activities	DID NOT PARTICIPATE	DON'T KNOW	Total Respondents
2012 ShakeOut (This year)	**96.08%** 147	**28.10%** 43	**20.92%** 32	**32.68%** 50	**0.00%** 0	**0.00%** 0	153
2011 ShakeOut	**18.27%** 19	**11.54%** 12	**3.85%** 4	**5.77%** 6	**67.31%** 70	**9.62%** 10	104
2010 ShakeOut	**12.50%** 13	**8.65%** 9	**1.92%** 2	**1.92%** 2	**71.15%** 74	**12.50%** 13	104
2009 ShakeOut	**9.71%** 10	**8.74%** 9	**2.91%** 3	**0.97%** 1	**71.84%** 74	**16.50%** 17	103
2008 ShakeOut (So. California ONLY)	**0.00%** 0	**0.00%** 0	**0.00%** 0	**0.00%** 0	**85.71%** 72	**14.29%** 12	84

Evaluating tsunami education programmes in Washington State:

A summary of research to 2014

David Johnston[1], Vicki Johnson[1], Julia Becker[1], Graham Leonard[1], Stuart Fraser[1], Wendy Saunders[1], Kim Wright[1], Douglas Paton[2], Chris Gregg[3], Bruce Houghton[4], John Schelling[5], Dave Nelson[5], George Crawford[5], Byrne Walker[5], Nate Wood[6]

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[2]School of Psychology, University of Tasmania, Launceston, Tasmania, New Zealand
[3]Department of Geosciences, East Tennessee State University, Johnson City, TN 37614, USA
[4]Department of Geology & Geophysics, University of Hawaii at Manoa, Honolulu, Hawaii 96822,USA
[5]Washington Emergency Management Division, Camp Murray, WA 98430-5112, USA
[6]U.S. Geological Survey, Portland, OR 97201, USA

Introduction

Improving the response capacity of coastal communities at risk to tsunami presents an on-going challenge. To meet this challenge Washington State Emergency Management has supported the development of an evaluation program since 2001 to monitor and improve its earthquake and tsunami education and preparedness programs. Table 1 outlines the evaluation research that has taken place in Washington State since 2001.

Conclusions

Our work has used multiple research and outreach approaches to bring about measureable change in the tsunami preparedness of coastal Washington residents. Our research supports decades of international research that shows that public education programs should include a traditional information dissemination element, as well as a more interactive community-based component [10, 11].

Acknowledgements

The work has been supported by the State of Washington, in partnership with GNS Science and Massey University in New Zealand.

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4. Johnston, D., Becker, J., Gregg, C., Houghton, B., Paton, D., Leonard, G., Garside, R. Developing warning and disaster response capacity in the tourism sector in coastal Washington, USA. Disaster Prevention and Management 2007; 16: 210-216.
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7. Becker, J., Johnston, D., Lazrus, H., Crawford, G., Nelson, D. Use of traditional knowledge in emergency management for tsunami hazard: A case study from Washington State, USA. Disaster Prevention and Management 2008; 17: 488-502.
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11. Ronan, K.R.; Johnston, D.M.; Becker, J.S.; Ronan, K.R; Paton, D. School and community-based hazards education and links to disaster-resilient communities. Regional development dialogue 2007; 28(2): 99-109.

Year	Research	Conclusions
2001	Survey of resident and visitor perceptions of and preparedness for tsunami hazards on the west coast of Washington.	Research found high awareness of and access to information about tsunami hazard but low to moderate levels of preparedness. There was identification of a need for community engagement strategies and development of education materials [1,2,3].
2003	Focus groups and a school survey examining beliefs regarding preparedness and warnings.	
2005	Survey assessing tsunami hazard knowledge, response planning and signage for tourism (Figure 1). Ocean Shores, Washington.	Research found levels of staff training and preparedness for tsunami were very low. Suggestions were made on how to improve preparedness including: analyses of training needs, workshops, development of a Disaster Response Guidebook for Hotels and Motels, simulations and employee training to empower both businesses and employees [4].
2006, 2007 and 2010	Survey to asses tsunami hazard knowledge and response planning within the tourism sector, Ocean Shores, Washington	Follow-up studies (post 2005) noted improvements in training and levels of preparedness within the tourism sector [5, 6]. While the newly developed guidebook was found to be extremely beneficial, it was concluded that the guidebook alone would not bring about the desired levels of sustained preparedness. The guidebook needed to be augmented with other training interventions [5,6].
2008	Case study where traditional stories ("oral tradition") were being used in a contemporary context for tsunami education, West Coast Washington	It was found that traditional knowledge was being used effectively to undertake hazard education and enhance response to warnings. E.g. Development of the video titled "Run to Higher Ground!" [7]
2010	Assessment of community-based tsunami evacuation drills and siren tests.	It provided general recommendations for the following: designing a warning system with the community for effective evacuation response; conducting a community-led evaluation; conducting a community-lead evacuation exercise; "keeping it simple"; evaluation criteria for observers and participants; community-based post exercise work-up [8].
2012	Research evaluated how well children in grades six through 12 in two coastal Washington state school districts understood the objectives and consequences of the protective actions practiced during the ShakeOut drill, including a practice of tsunami vertical evacuation inside the schools.	The evaluation found that students had high levels of correct knowledge about protective actions for earthquakes and tsunami before ShakeOut. However many students did not understand the causes of injury during earthquakes and had difficulty applying the protective actions they had practiced in the classroom to situations outside the classroom. These results indicate that school-based disaster drills should be complemented with additional classroom lessons and discussion [9].

Table 1: Tsunami and earthquake evaluation research in Washington State.

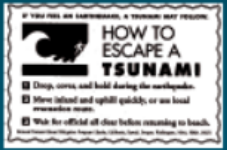

IF YOU FEEL AN EARTHQUAKE, A TSUNAMI MAY FOLLOW:
HOW TO ESCAPE A TSUNAMI
Drop, cover, and hold during the earthquake.
Move inland and uphill quickly, or use local evacuation route.
Wait for official all clear before returning to beach.

Figure 1: Signs distributed by Washington State Emergency Management office and displayed in one of the visited establishments.

Figure 2: Local Fireman from Greys Harbour Fire Service passing on the advisory notice to people coming to the beach 28 February 2010, following the tsunami advisory from the Chilean earthquake.

Get Ready to Shake Out.
DROP!
COVER!
October 18, 10:18 a.m.
ShakeOut
Register at ShakeOut.org/washington

Figure 3: Washington ShakeOut poster

New Tsunami Hazard Modeling for the Long Beach Peninsula

by

Timothy J. Walsh, Edison Gica, Diego Arcas, Vasily Titov

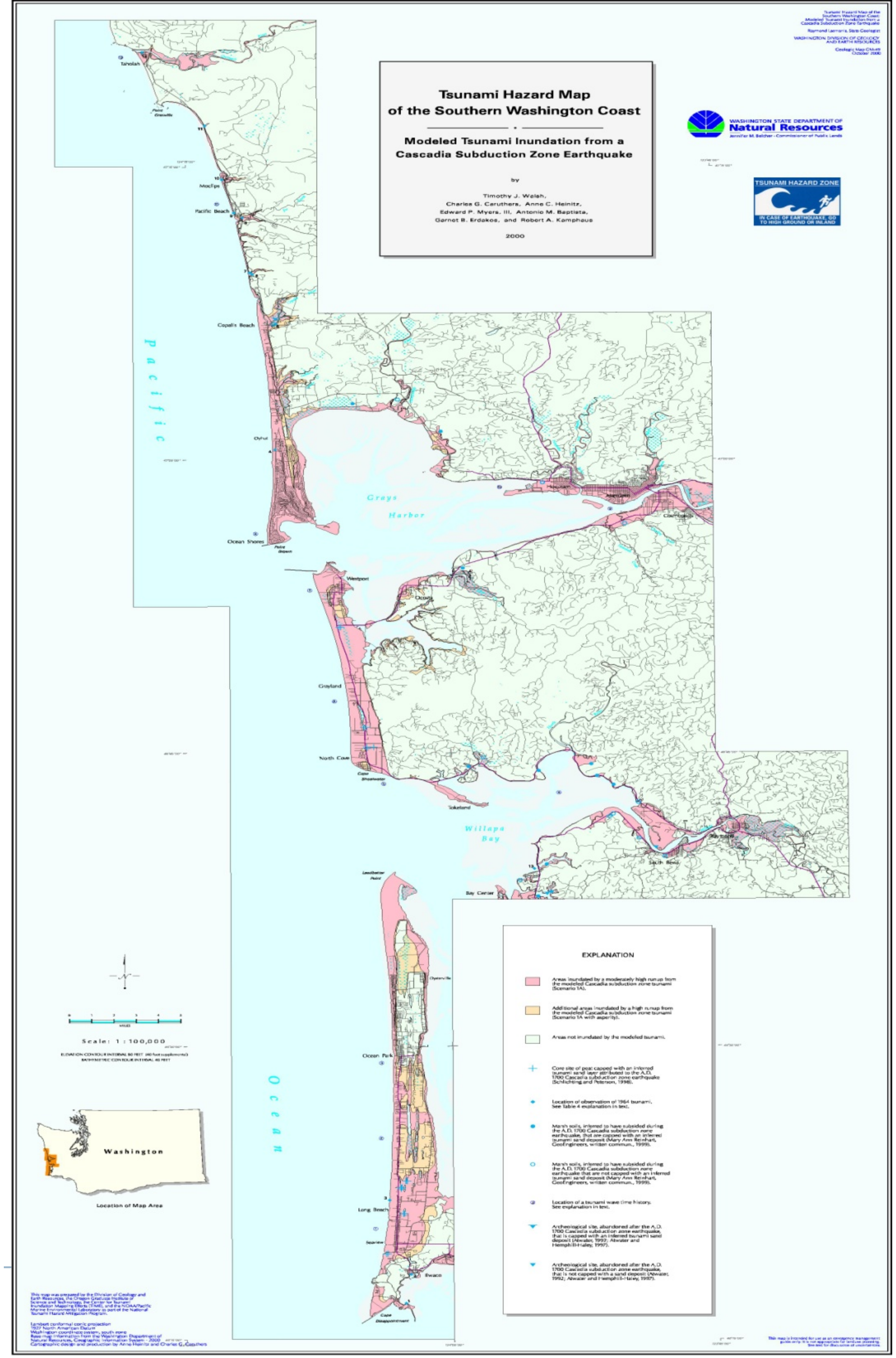
Washington Department of Natural Resources

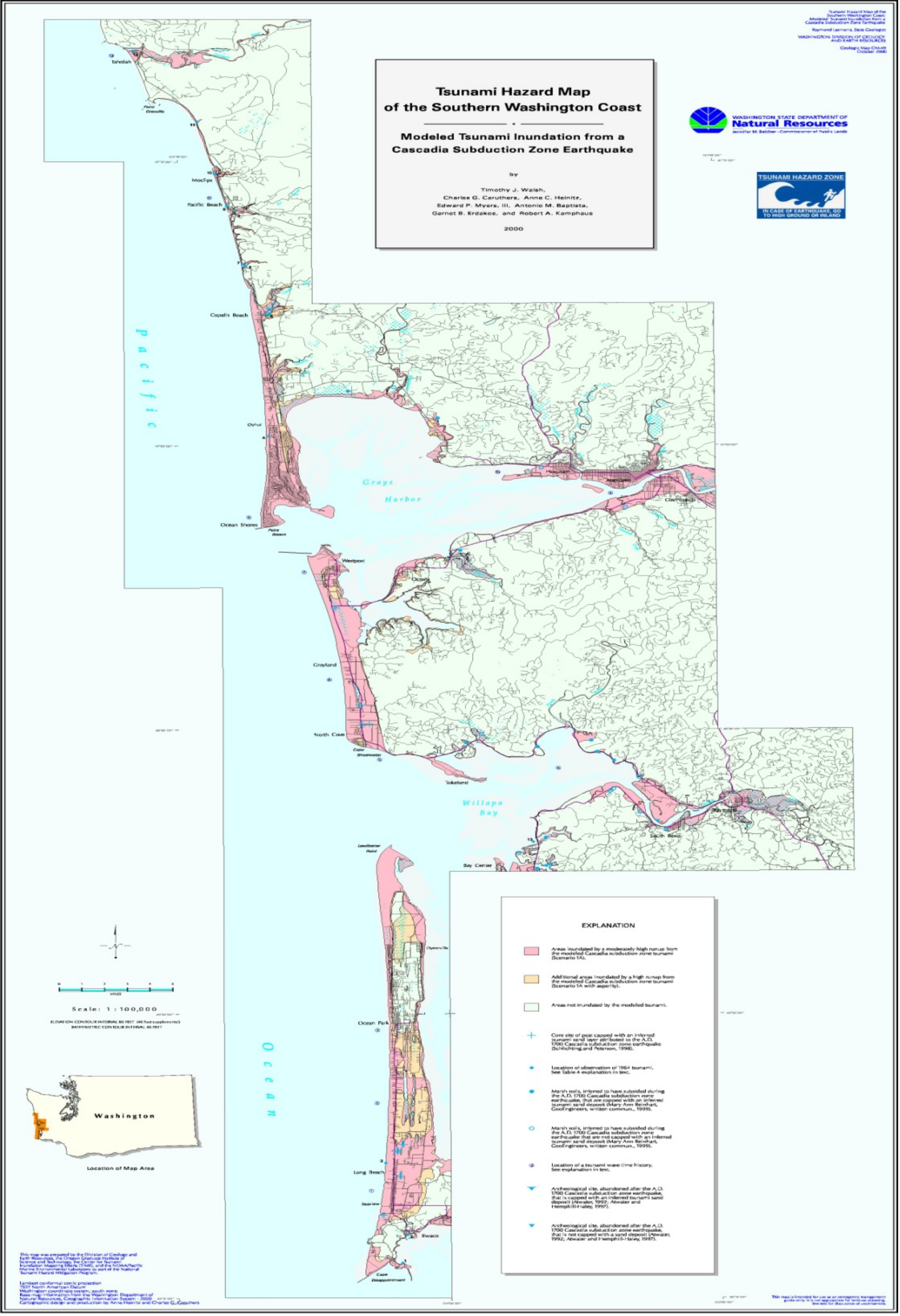
Division of Geology and Earth Resources

And NOAA PMEL

December, 2014

This is the first tsunami hazard map that we developed for the southern Washington coast. The area is within the Columbia River littoral cell and is dominated by accretionary shoreforms marked by low relief. This is where most of the resident population of the outer Washington coast lives and where evacuation is most difficult.


Tsunami Hazard Map of the Southern Washington Coast
Modeled Tsunami Inundation from a Cascadia Subduction Zone Earthquake
by
Timothy J. Walsh, Charles G. Caruthers, Anne C. Heinitz, Edward P. Myers, III, Antonio M. Baptista, Garnet B. Erdakos, and Robert A. Kamphaus
2000
WASHINGTON STATE DEPARTMENT OF Natural Resources
TSUNAMI HAZARD ZONE
IN CASE OF EARTHQUAKE, GO TO HIGH GROUND OR INLAND
Pacific
Ocean
Grays Harbor
Willapa Bay
Moclips
Pacific Beach
Copalis Beach
Ocean Shores
Westport
Grayland
North Cove
Tokeland
Bay Center
South Bend
Ocean Park
Long Beach
Ilwaco
Cape Disappointment
EXPLANATION
Scale 1:100,000
Washington
Location of Map Area



Tsunami Hazard Map
of the Southern Washington Coast

Modeled Tsunami Inundation from a
Cascadia Subduction Zone Earthquake

by

Timothy J. Walsh,
Charles G. Caruthers, Anne C. Heinitz,
Edward P. Myers, III, Antonio M. Baptista,
Garnet B. Erdakos, and Robert A. Kamphaus

2000

EXPLANATION

🟥 Areas inundated by a moderately high runup from the modeled Cascadia subduction zone tsunami (Scenario 1A).

🟧 Additional areas inundated by a high runup from the modeled Cascadia subduction zone tsunami (Scenario 1A with asperity).

⬜ Areas not inundated by the modeled tsunami.

+ Core site of peat capped with an inferred tsunami sand layer attributed to the A.D. 1700 Cascadia subduction zone earthquake (Schlichting and Peterson, 1998).

◆ Location of observation of 1964 tsunami. See Table 4 explanation in text.

● Marsh soils, inferred to have subsided during the A.D. 1700 Cascadia subduction zone earthquake, that are capped with an inferred tsunami sand deposit (Mary Ann Reinhart, GeoEngineers, written commun., 1999).

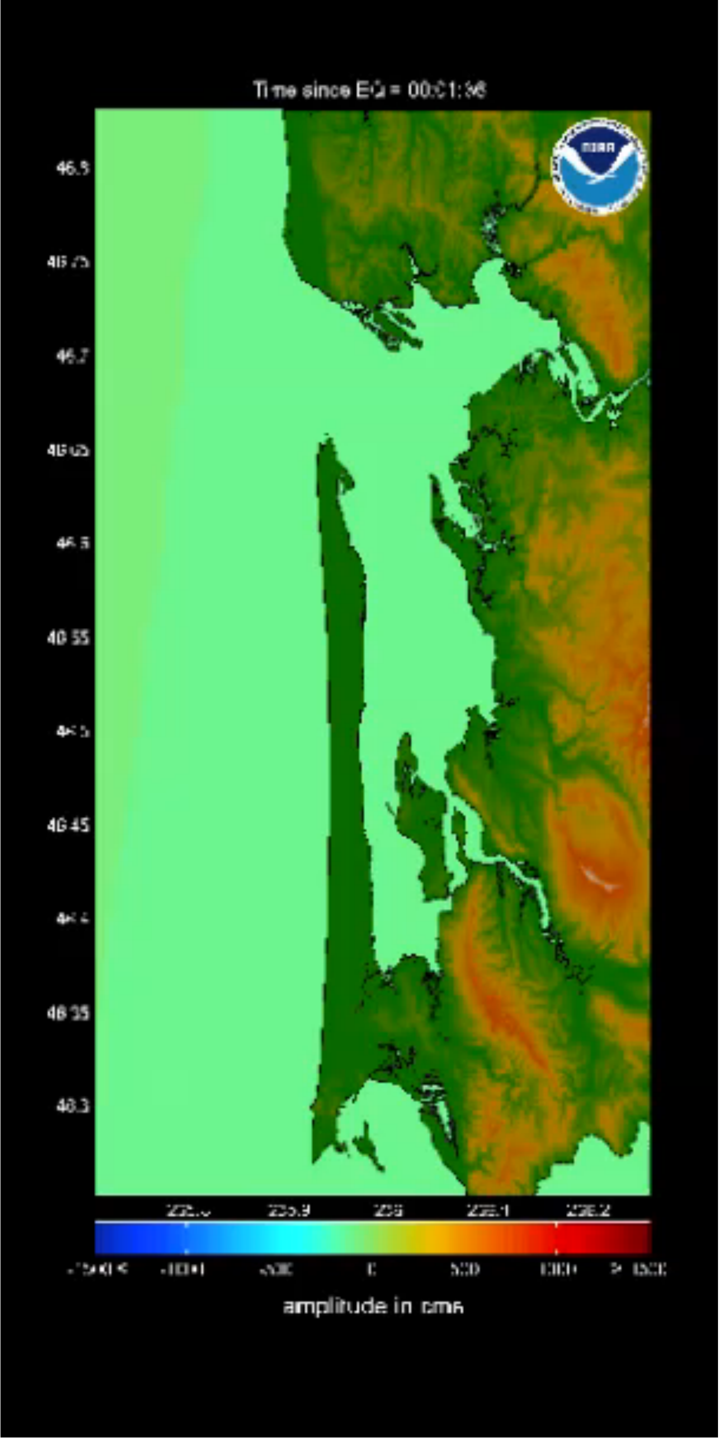
○ Marsh soils, inferred to have subsided during the A.D. 1700 Cascadia subduction zone earthquake that are not capped with an inferred tsunami sand deposit (Mary Ann Reinhart, GeoEngineers, written commun., 1999).

② Location of a tsunami wave time history. See explanation in text.

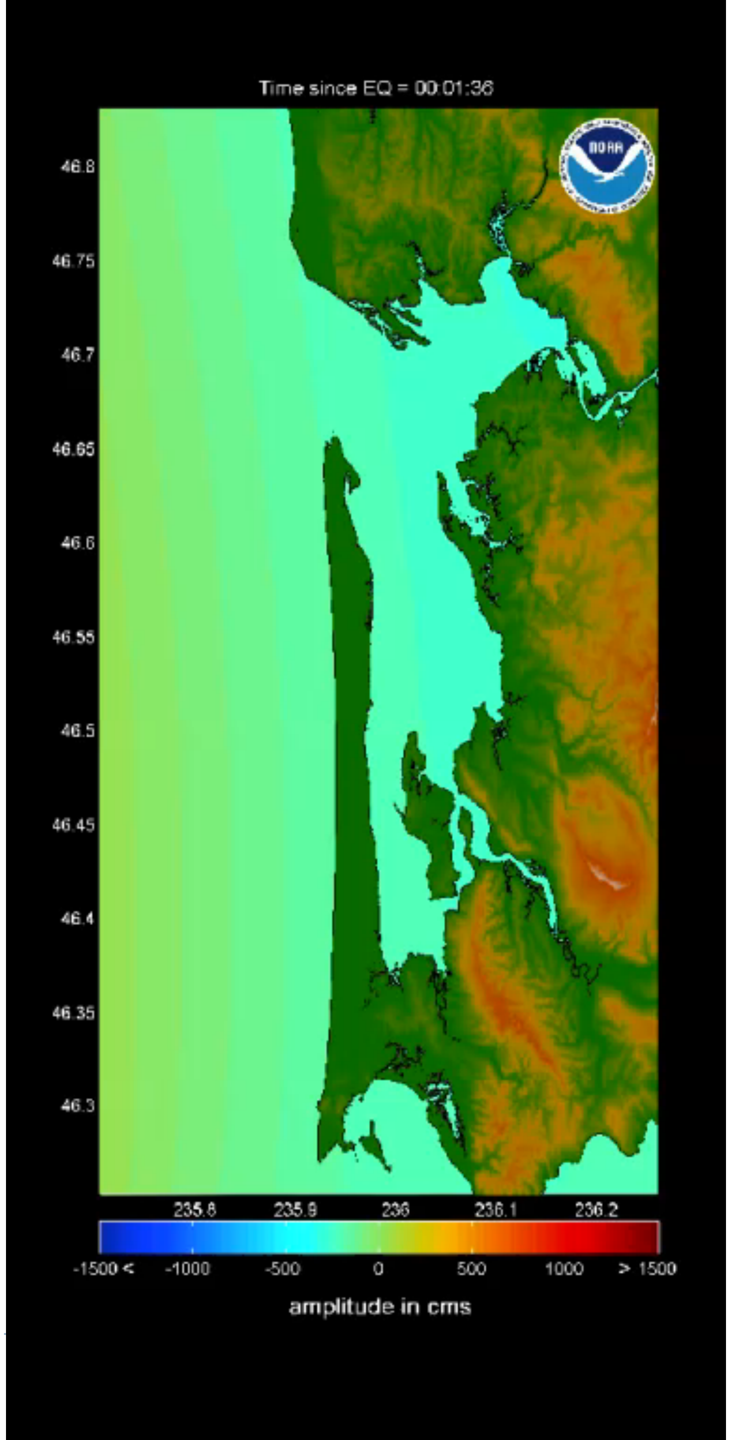
▼ Archeological site, abandoned after the A.D. 1700 Cascadia subduction zone earthquake, that is capped with an inferred tsunami sand deposit (Atwater, 1992; Atwater and Hemphill-Haley, 1997).

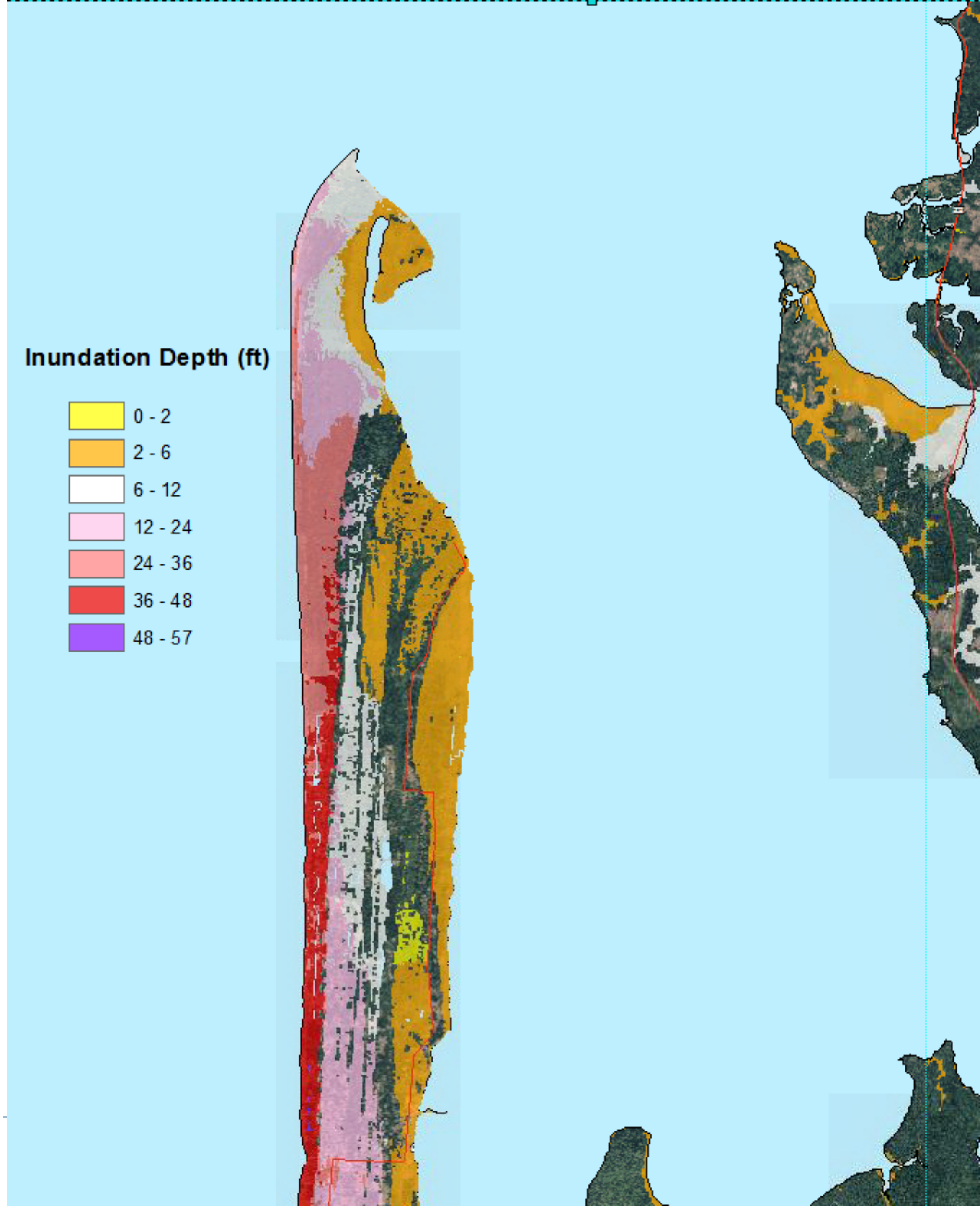
▼ Archeological site, abandoned after the A.D. 1700 Cascadia subduction zone earthquake, that is not capped with a sand deposit (Atwater, 1992; Atwater and Hemphill-Haley, 1997).

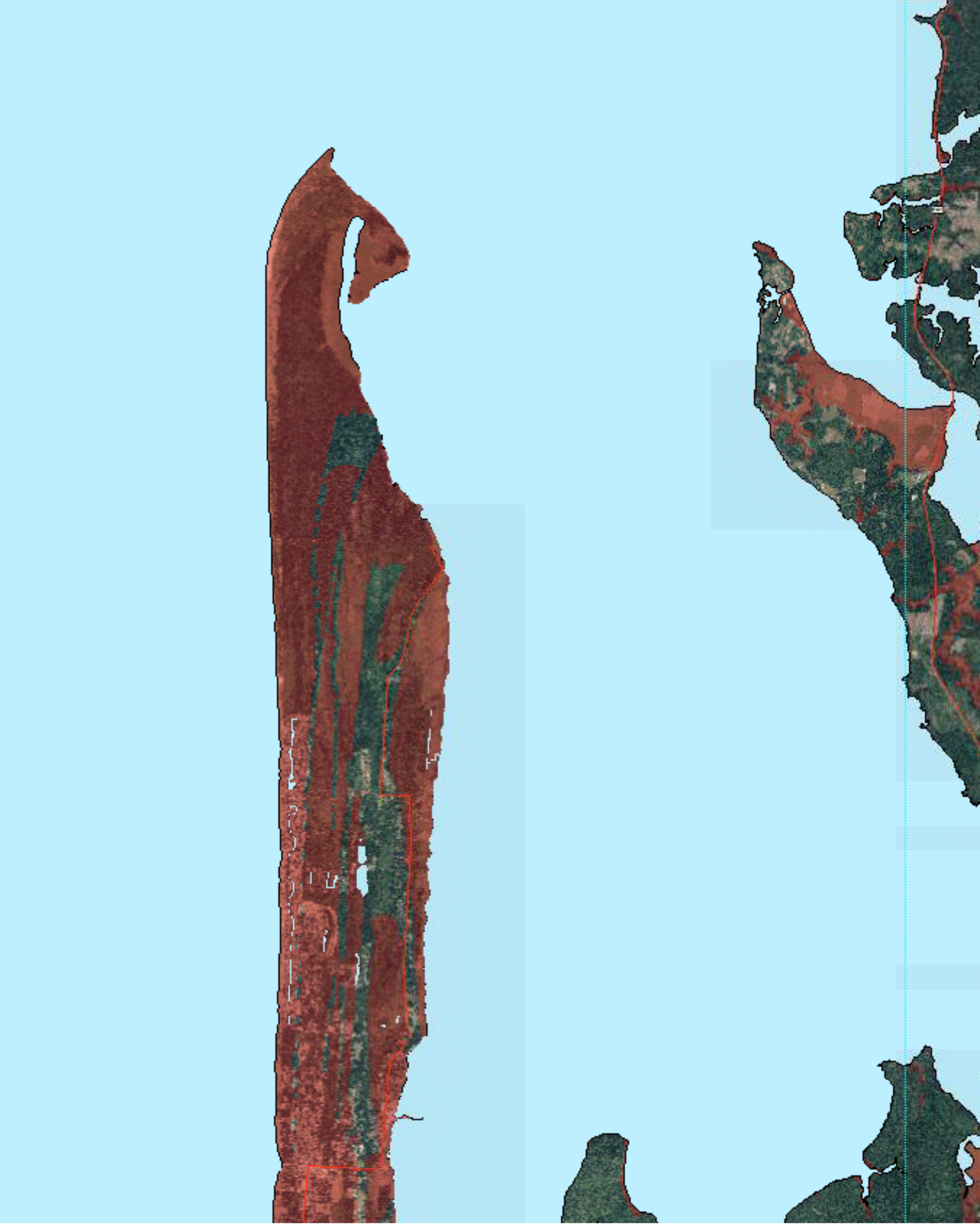
This is an animation of what we consider a repeat of the AD 1700 tsunami. This is the most likely event and was the basis for the previous evacuation brochures.

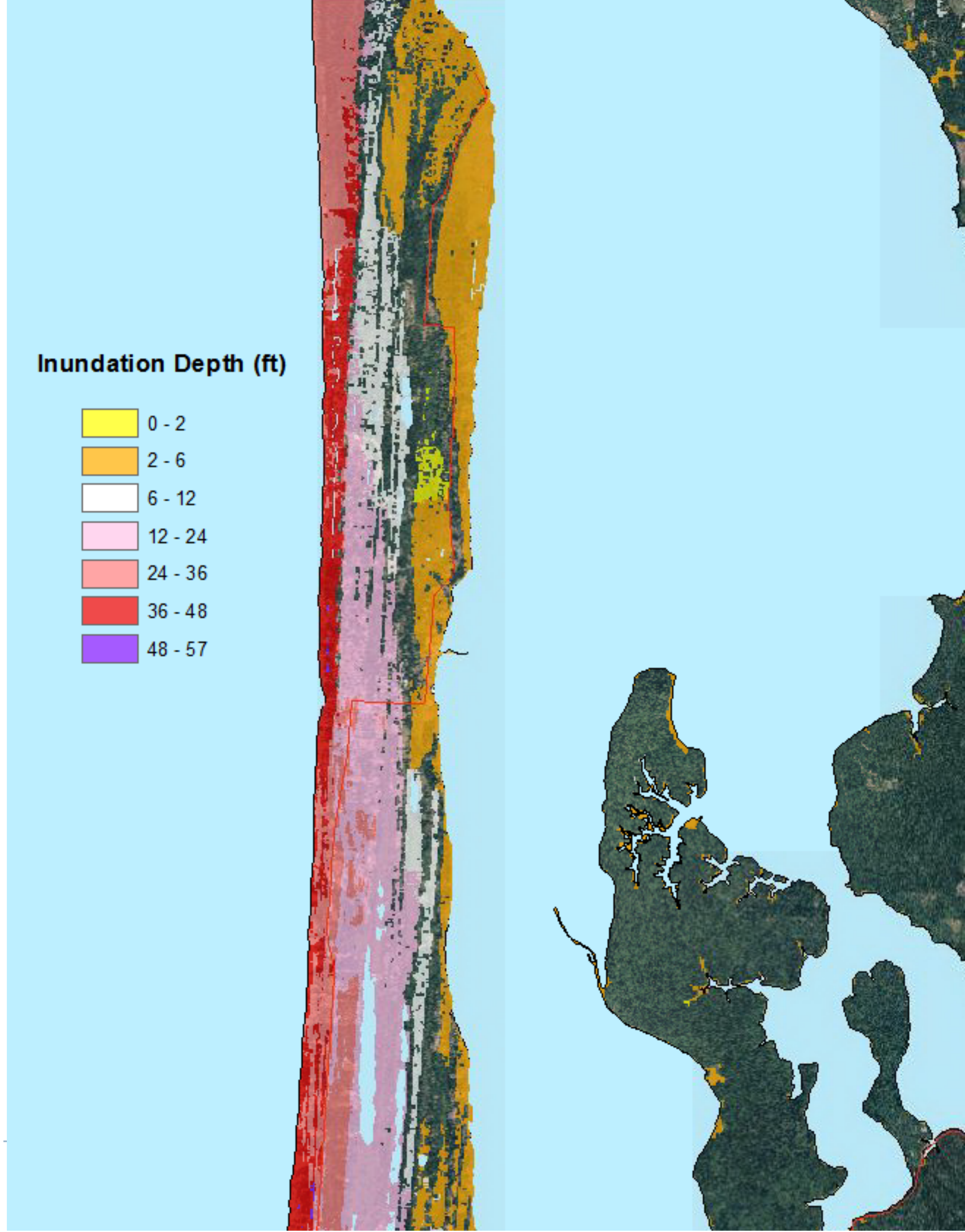


This is an animation of the L1 scenario, which is considered to envelope ~95% of the total hazard and to have a recurrence interval of about 2,500 years. This is the basis for the new evacuation brochures.




Inundation Depth (ft)
0 - 2
2 - 6
6 - 12
12 - 24
24 - 36
36 - 48
48 - 57




Inundation Depth (ft)
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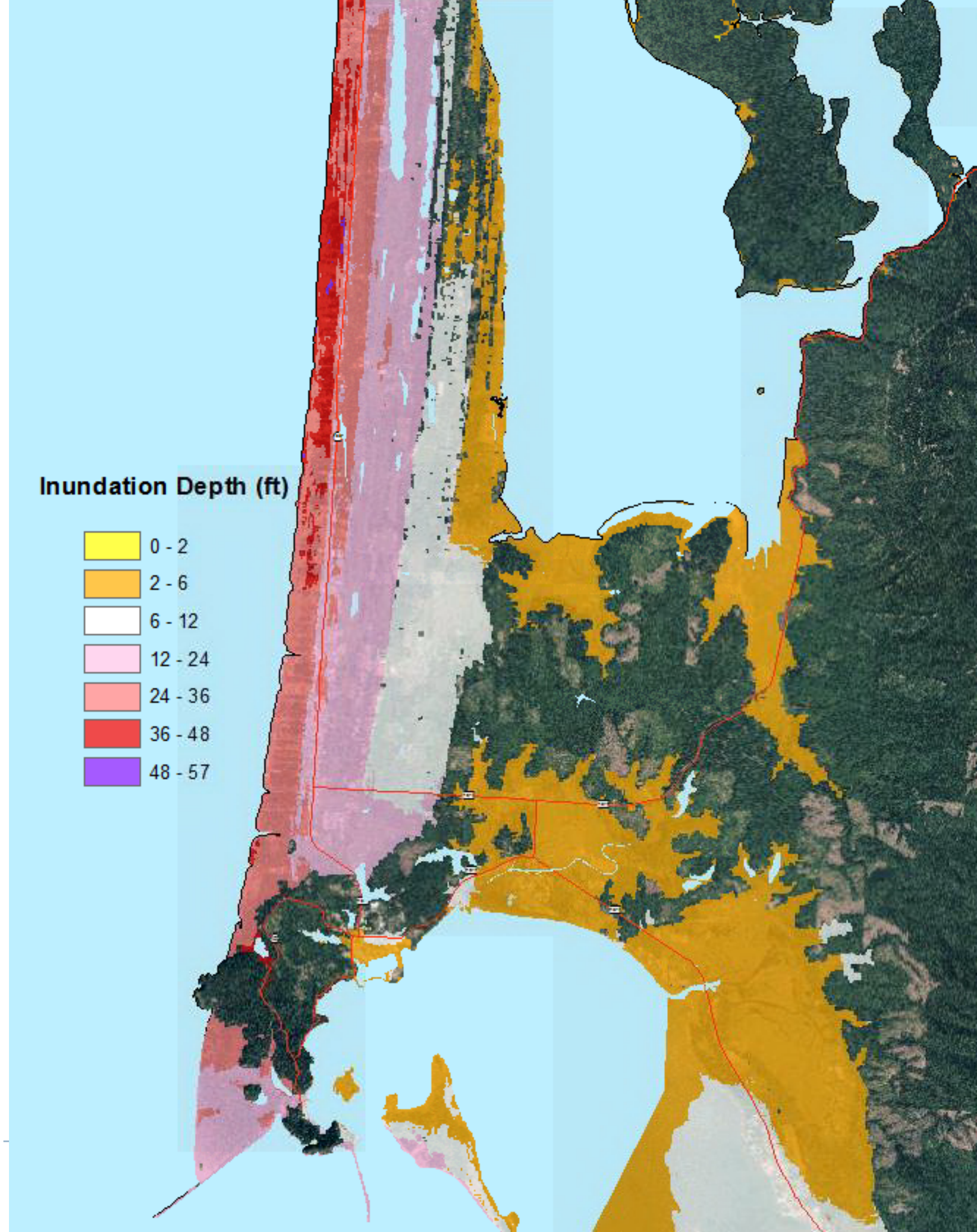
2 - 6
6 - 12
12 - 24
24 - 36
36 - 48
48 - 57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0 - 2
2 - 6
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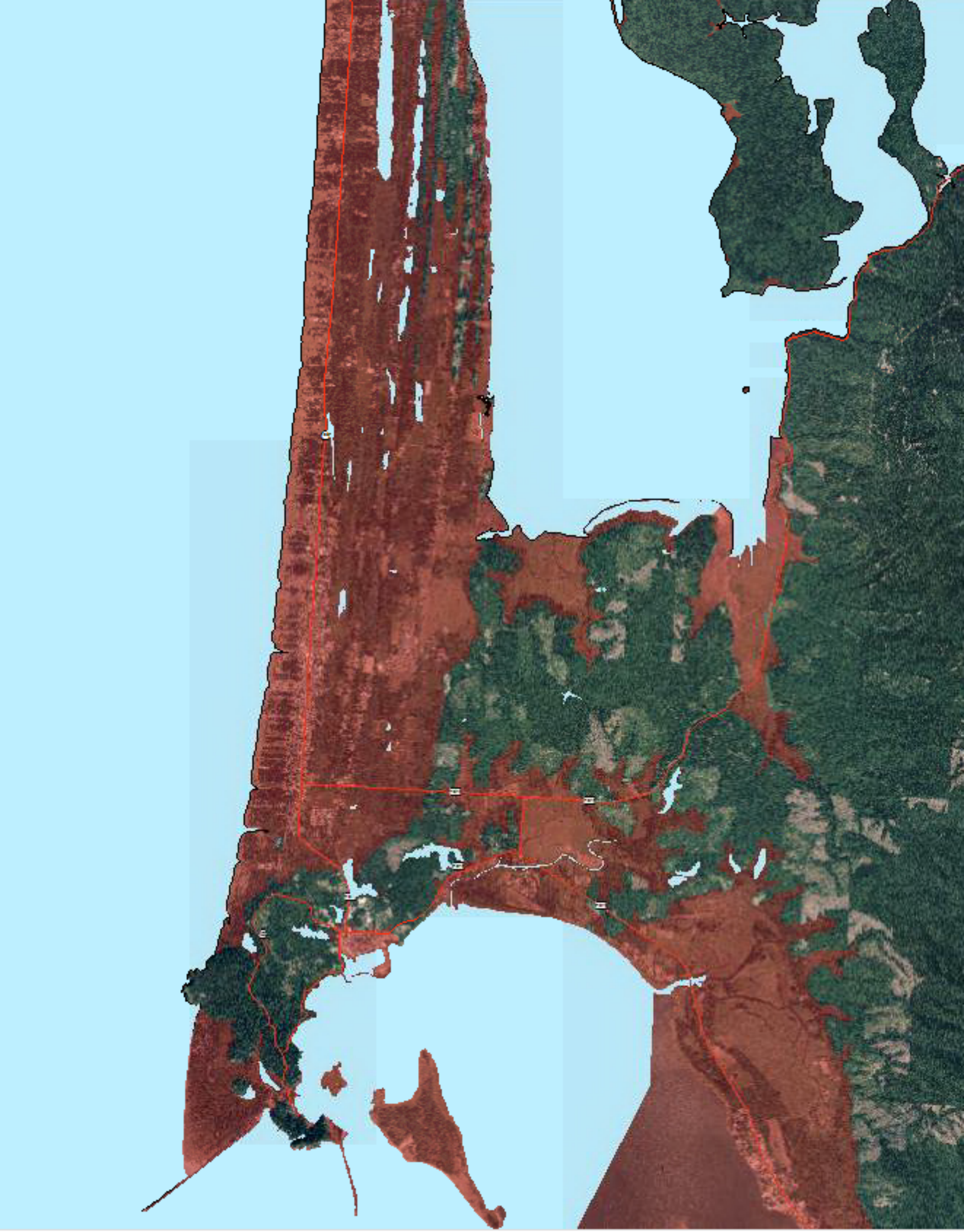
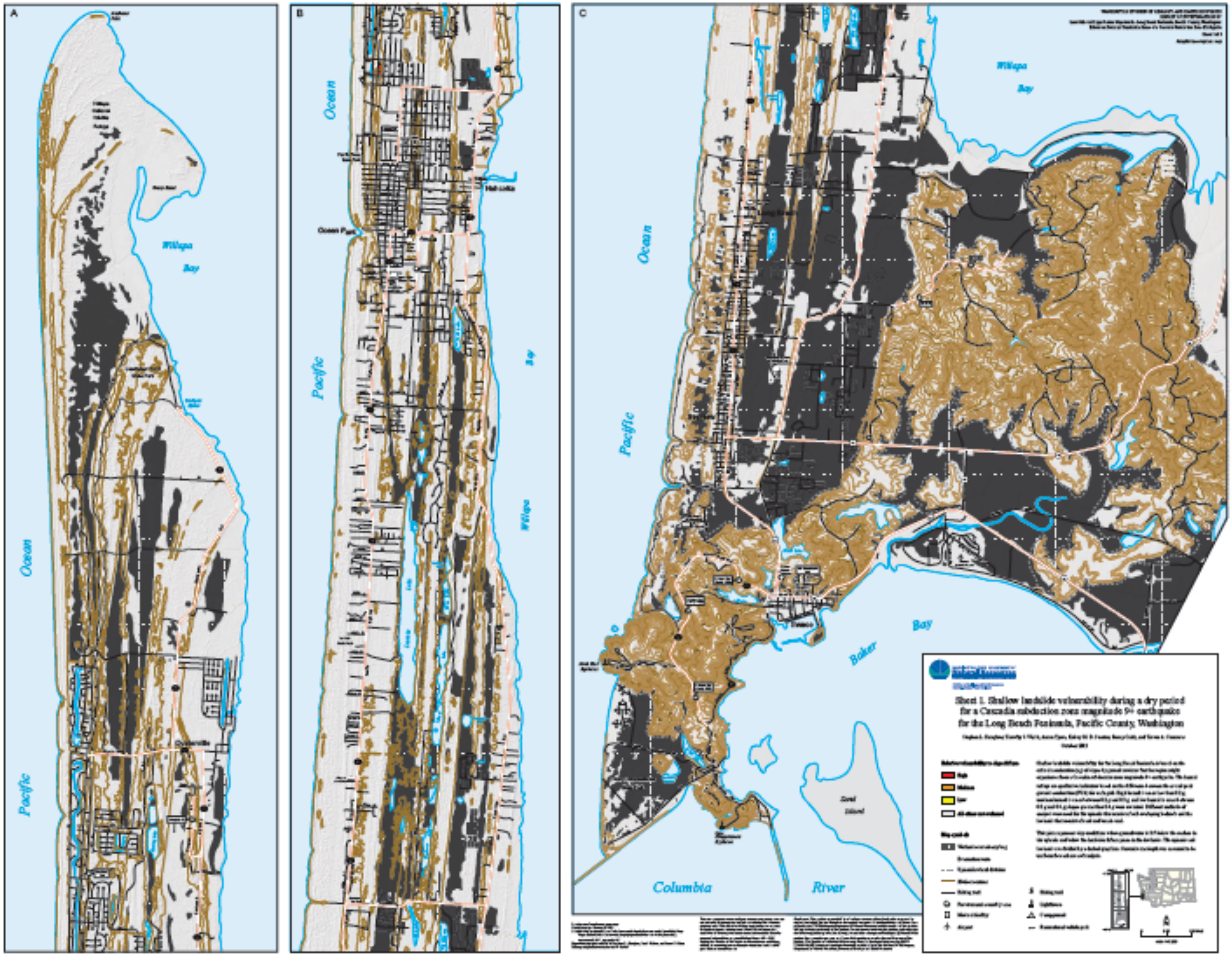
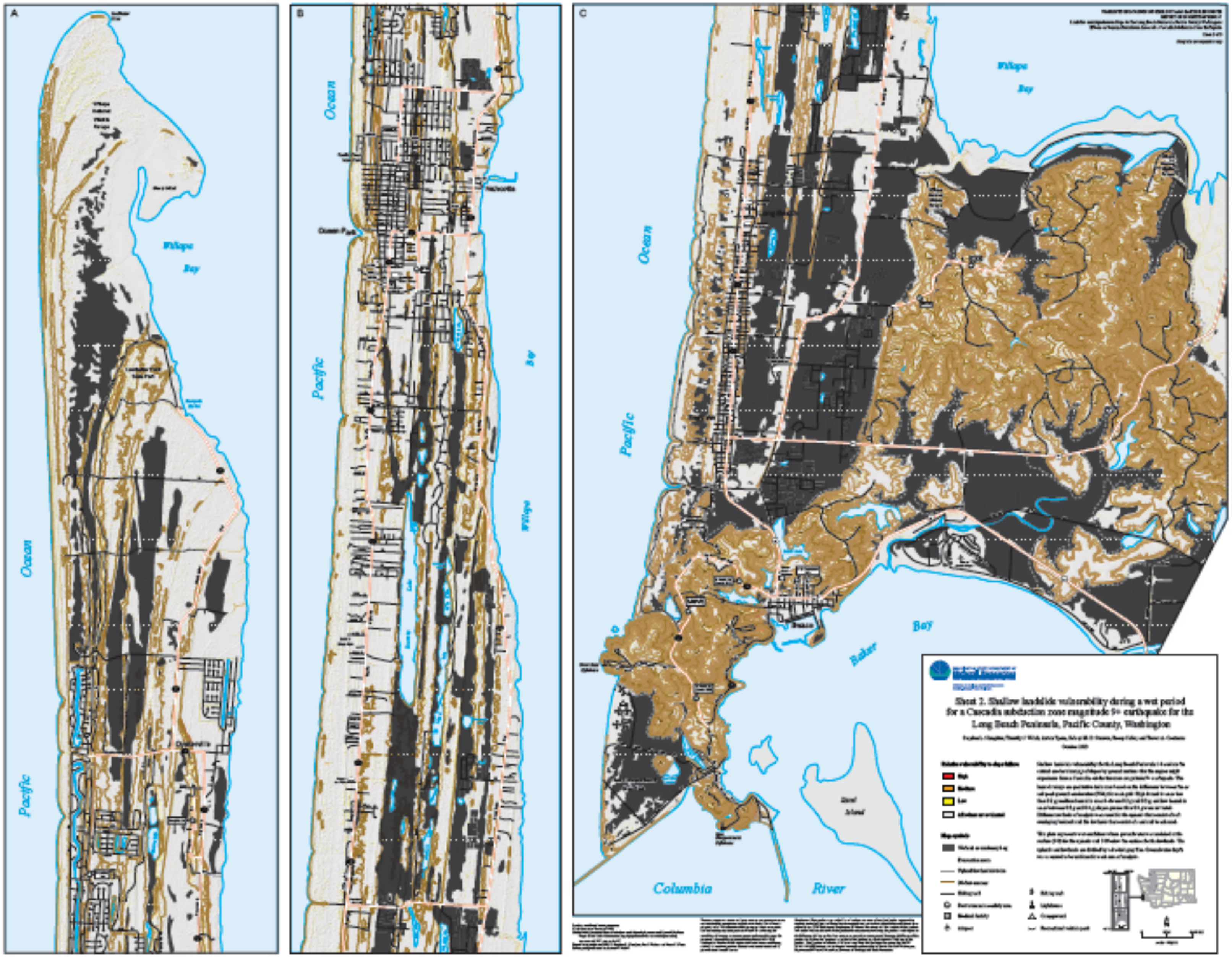
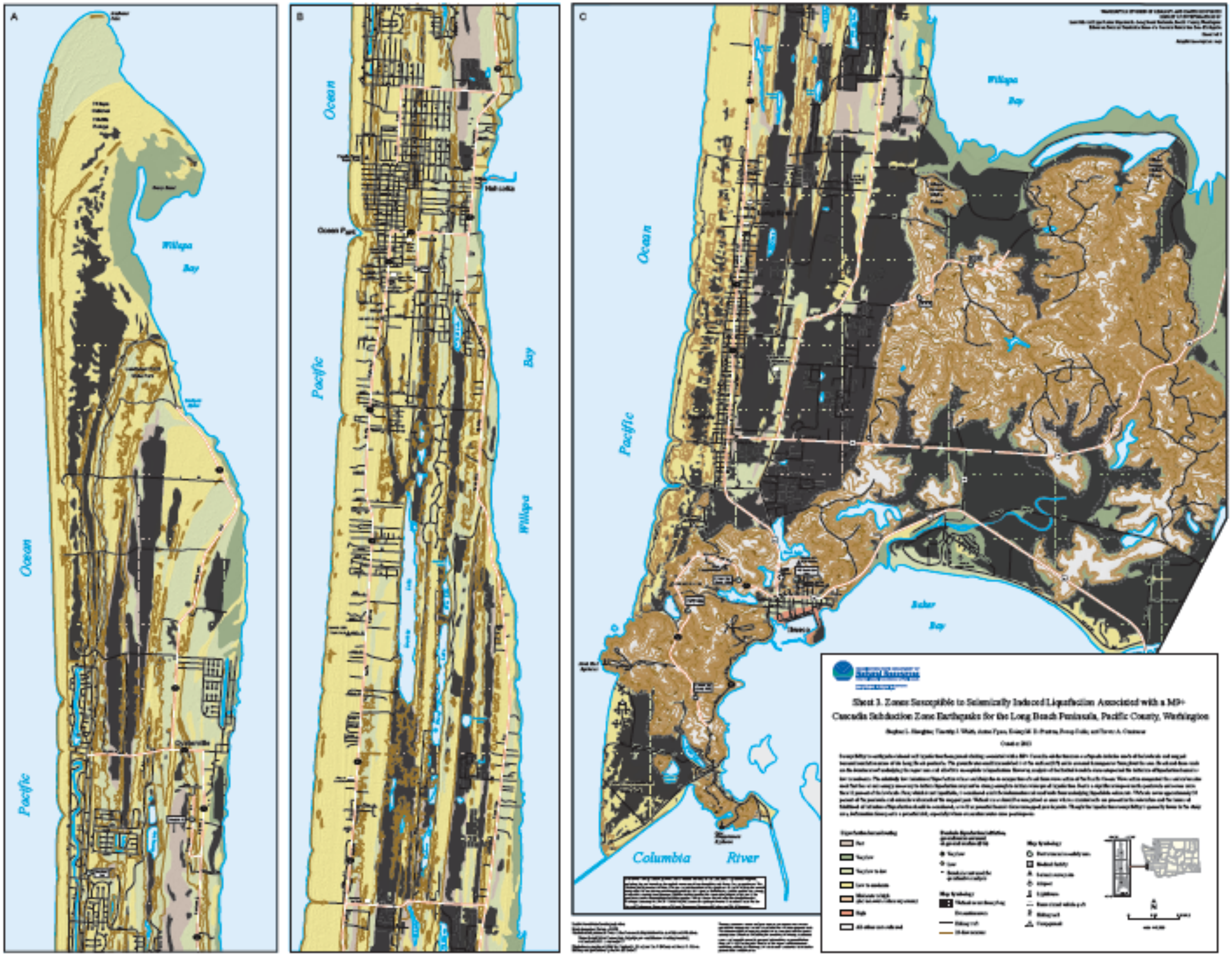
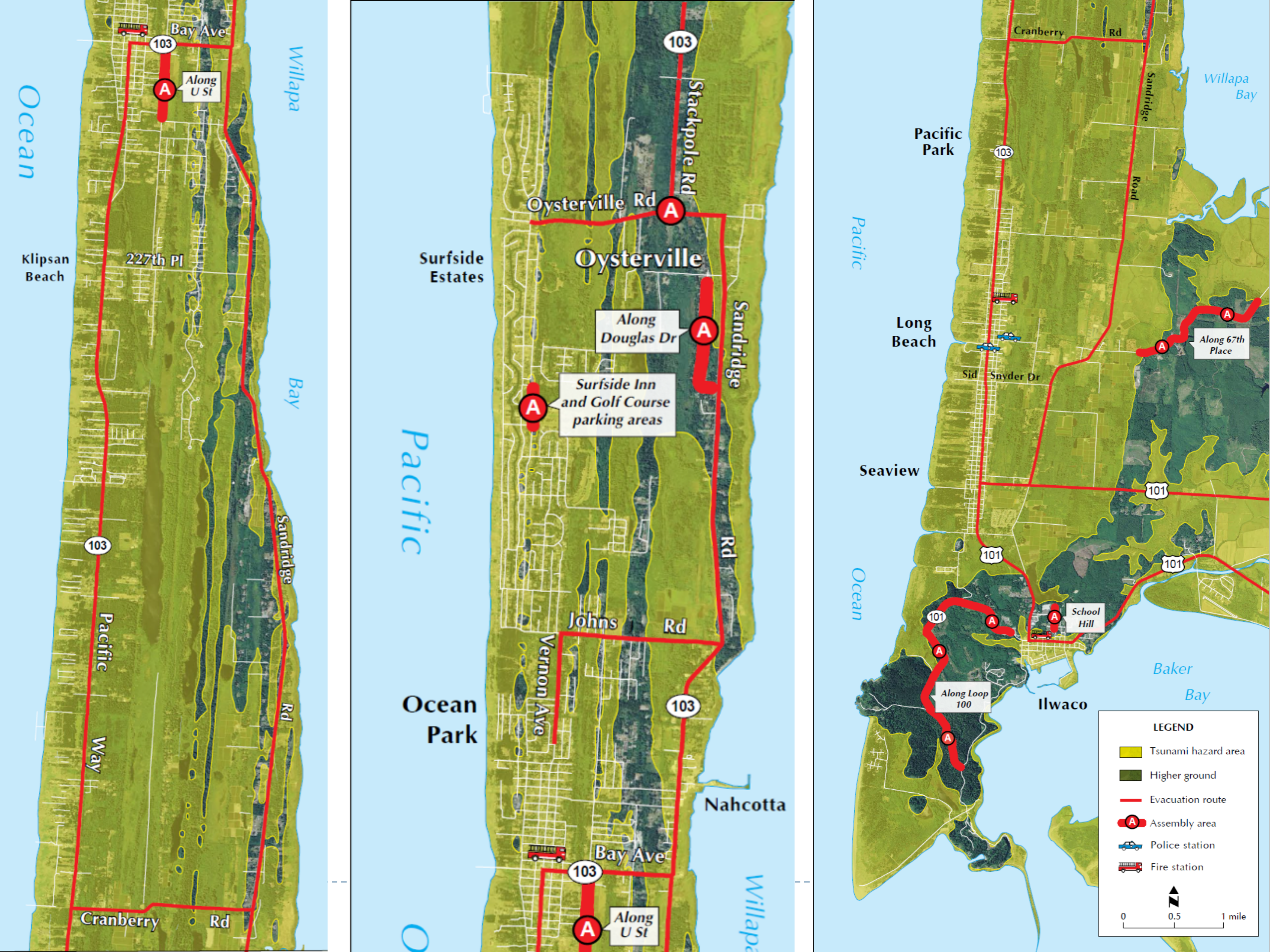
24 - 36
36 - 48
48 - 57



A
Willapa
Bay
Ocean
Pacific
B
Ocean
Ocean Park
Nahcotta
Pacific
Bay
Willapa
C
Willapa
Bay
Ocean
Pacific
Baker
Bay
Sand
Island
Columbia
River
Sheet 1. Shallow landslide vulnerability during a dry period for a Cascadia subduction zone magnitude 9+ earthquake for the Long Beach Peninsula, Pacific County, Washington
High
Medium
Low


A
B
C
Pacific
Ocean
Willapa
Bay
Ocean Park
Nahcotta
Columbia
River
Baker
Bay
Sand
Island
Sheet 2. Shallow landslide vulnerability during a wet period for a Cascadia subduction zone magnitude 9+ earthquake for the Long Beach Peninsula, Pacific County, Washington
High
Medium
Low

A
B
C
Pacific
Ocean
Willapa
Bay
Ocean Park
Nahcotta
Oysterville
Long Beach
Ilwaco
Baker
Bay
Columbia
River
Sheet 3. Zones Susceptible to Seismically Induced Liquefaction Associated with a M9+ Cascadia Subduction Zone Earthquake for the Long Beach Peninsula, Pacific County, Washington


Bay Ave
103
A
Along U St
Ocean
Willapa
Klipsan Beach
227th Pl
Bay
103
Sandridge
Pacific
Way
Rd
Cranberry
Rd
103
Stackpole Rd
Oysterville Rd
A
Surfside Estates
Oysterville
Along Douglas Dr
A
Sandridge
Surfside Inn and Golf Course parking areas
A
Pacific
Rd
Johns
Rd
Vernon Ave
Ocean Park
103
Nahcotta
Bay Ave
103
A
Along U St
O
Willapa
Cranberry
Rd
Sandridge
Willapa Bay
Pacific Park
103
Road
Long Beach
A
A
Along 67th Place
Sid
Snyder Dr
Pacific
Seaview
101
101
101
Ocean
101
A
A
School Hill
A
Baker
Bay
Along Loop 100
Ilwaco
A
LEGEND
Tsunami hazard area
Higher ground
Evacuation route
Assembly area
Police station
Fire station
N
0
0.5
1 mile

Even Magnitude 9 earthquakes and tsunamis can be survivable.

STATISTICS FROM 3.11

- 15,850 dead 3,281 still missing (as of 15th Feb 2012)
- 65% victims over 60 years old, 90%+ died from drowning
- Most Japanese houses became dislodged when water levels reached 2m (~6ft.) and over.
- Sea did not pull back before Tsunami because sea trench facing Japanese coast lifted not sank
- Initial wavefront was not as high as subsequent wave because upward displacement of seabed started gradually then jumped.

BUT, given all that…

Bet you didn’t know that…

95%+ of population within the tsunami hazard zone survived!

-Meg Sugimoto
Tokyo University

It begs the question…

WHY?

Lesson #1

Having a plan (*and practicing it*) works!

Tsunami Education = Lives Saved

“Children at the school had received tsunami training the Friday before the tsunami. When the teachers felt the quake, they led the children out the back of the school and up the hill”
“It saved the school,”
“Thank God those teachers knew what they were doing.”

- Peter Gurr of Maota, Samoa, 2009

Source: Kamaichi city

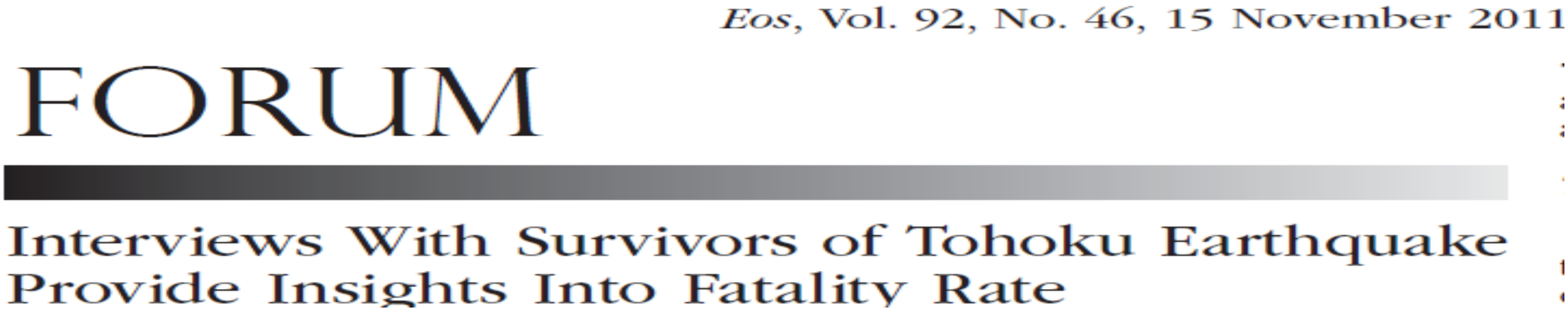
“The pre-disaster education guided the pupils at primary and junior high schools in Ishinomaki-city (one of the cities completely washed away) to safety during the tsunami. Miszuhama area in Ishinomaki has a total of 380 residents and about 130 households. However, only one person died and eight remain missing. It has been revealed that ***the people’s awareness of what do do at the event of an earthquake and regular conduct of (tsunami evacuation) exercises/drill had helped them***”

-Mr A. Koresawa, Asian Disaster Reduction Center
-Dr. Y. Kawaki, International Recovery Platform , Japan 2011

Quinault Indian Nation
Yellow Brick Road Walking Challenge

Lesson #2

Understanding "*Nature's Warnings*" is critical to survival!



Eos, Vol. 92, No. 46, 15 November 2011

FORUM

Interviews With Survivors of Tohoku Earthquake Provide Insights Into Fatality Rate

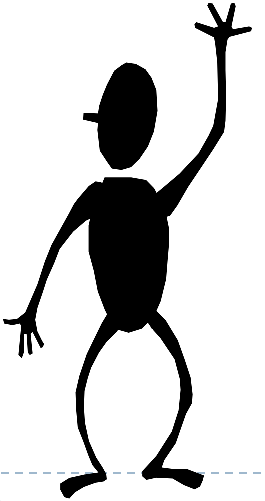
“*Many interviewees did not understand the generation of tsunamis and thus did not realize they needed to evacuate to safer areas immediately.*

In particular, although they understood that tsunamis are associated with earthquakes, they did not understand how a tsunami happens. Had they known, while they were feeling the strong shaking, that an abrupt vertical seafloor deformation displaces the enormous amount of seawater overlying it, they might have evacuated more quickly to safer highlands.”

Source: M. Ando, M. Ishida, Y. Nishikawa, C. Mizuki, and Y. Hayashi

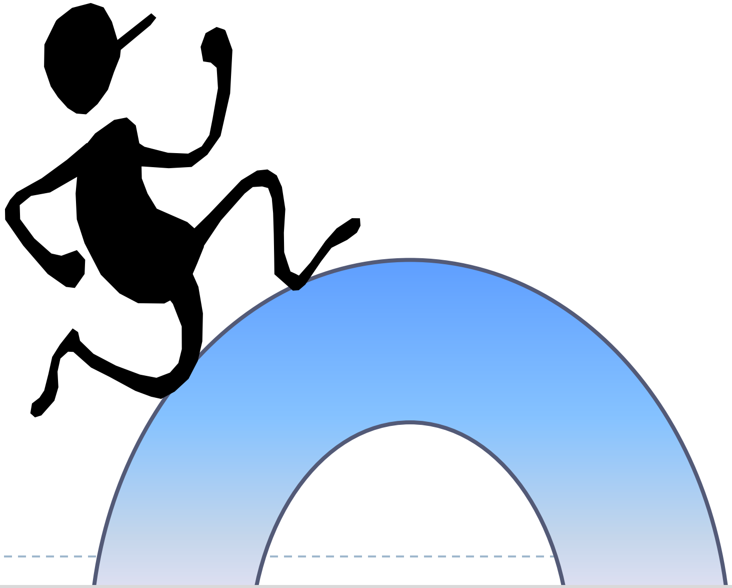
So, just what are Nature's Warnings?

- **If you feel the ground shake…Run!**
- **If you see water recede from the shoreline…Run!**
- **If you hear an unusually loud roar…Run!**



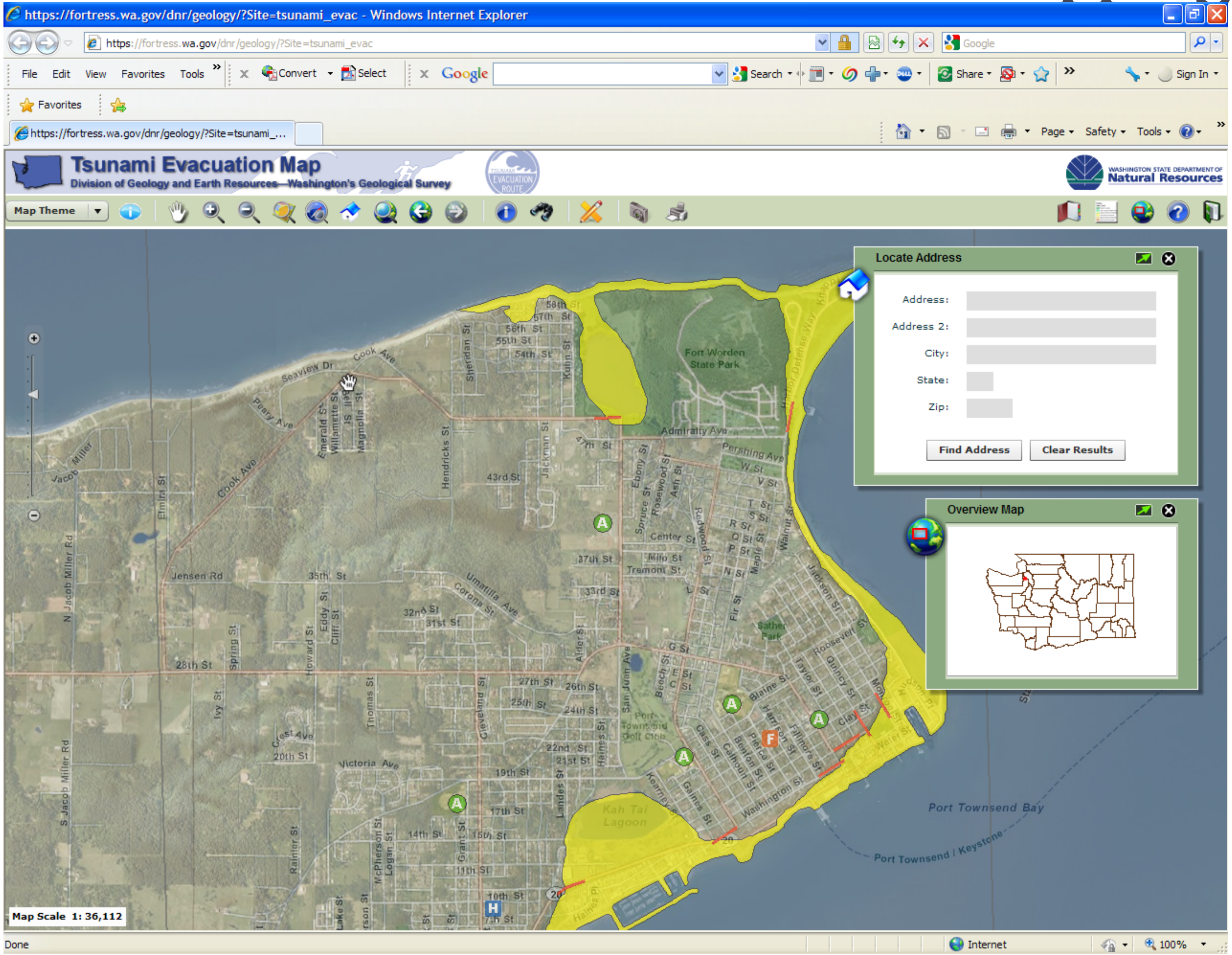
- You

You running



You running uphill (see how easy that was!)

NEW Online Tsunami Evacuation Mapping Tool



www.dnr.wa.gov – Geologic Information Portal

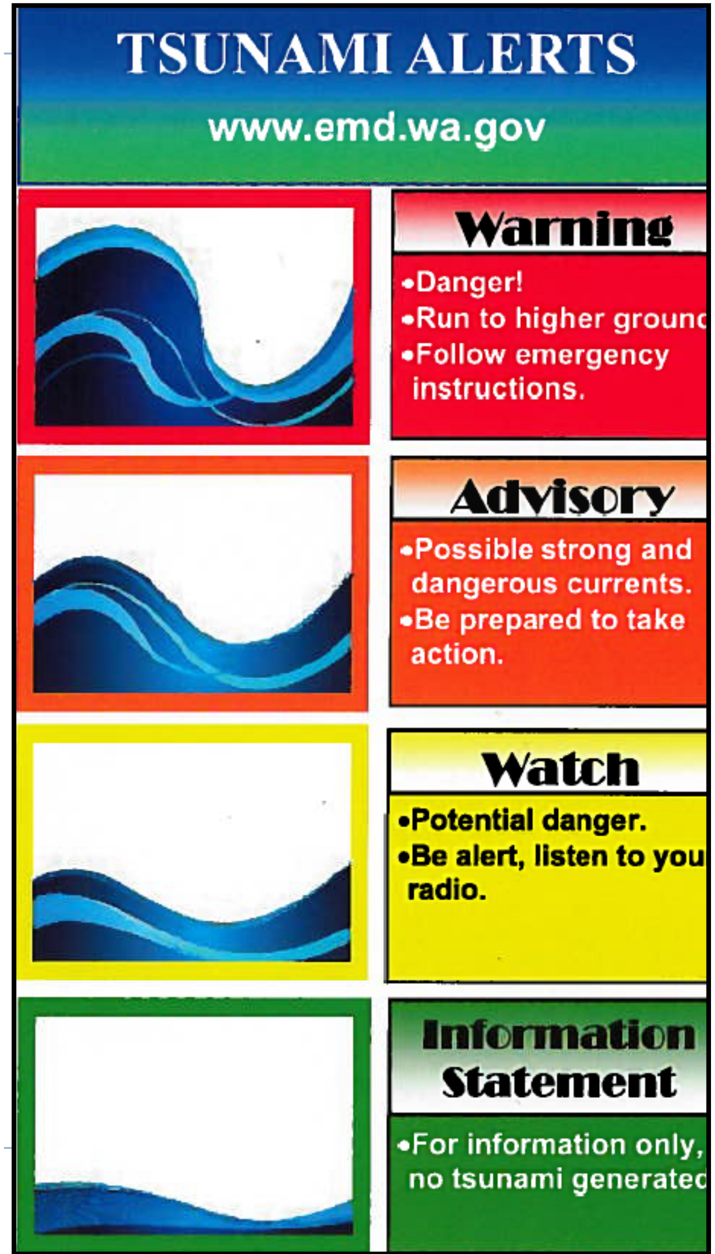
Know the Types of Official Warnings

Warning – initially based solely on seismic data, are issued as quickly as possible indicating that a significant inundation may occur.

Advisory – indicate potential beach and harbor danger; significant widespread inundation is not expected.

Watch – tell communities that a potentially dangerous distant event has occurred and to stay tuned for more information.

Information Statements - are issued to reassure those experiencing an earthquake that conditions do not warrant tsunami generation.



TSUNAMI ALERTS

www.emd.wa.gov

Warning

- Danger!
- Run to higher groun
- Follow emergency instructions.

Advisory

- Possible strong and dangerous currents.
- Be prepared to take action.

Watch

- Potential danger.
- Be alert, listen to you radio.

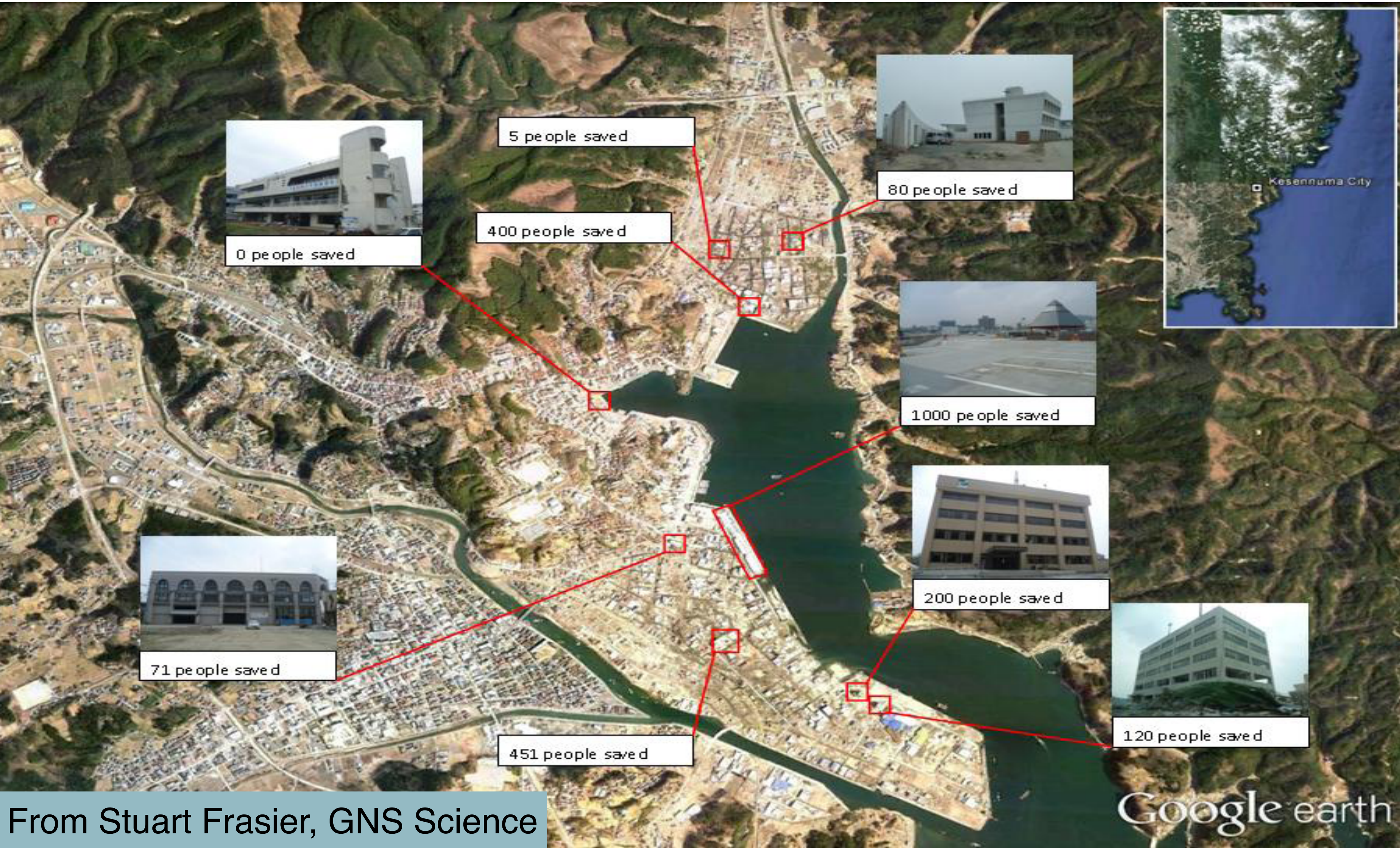
Information Statement

- For information only, no tsunami generate

Lesson #3

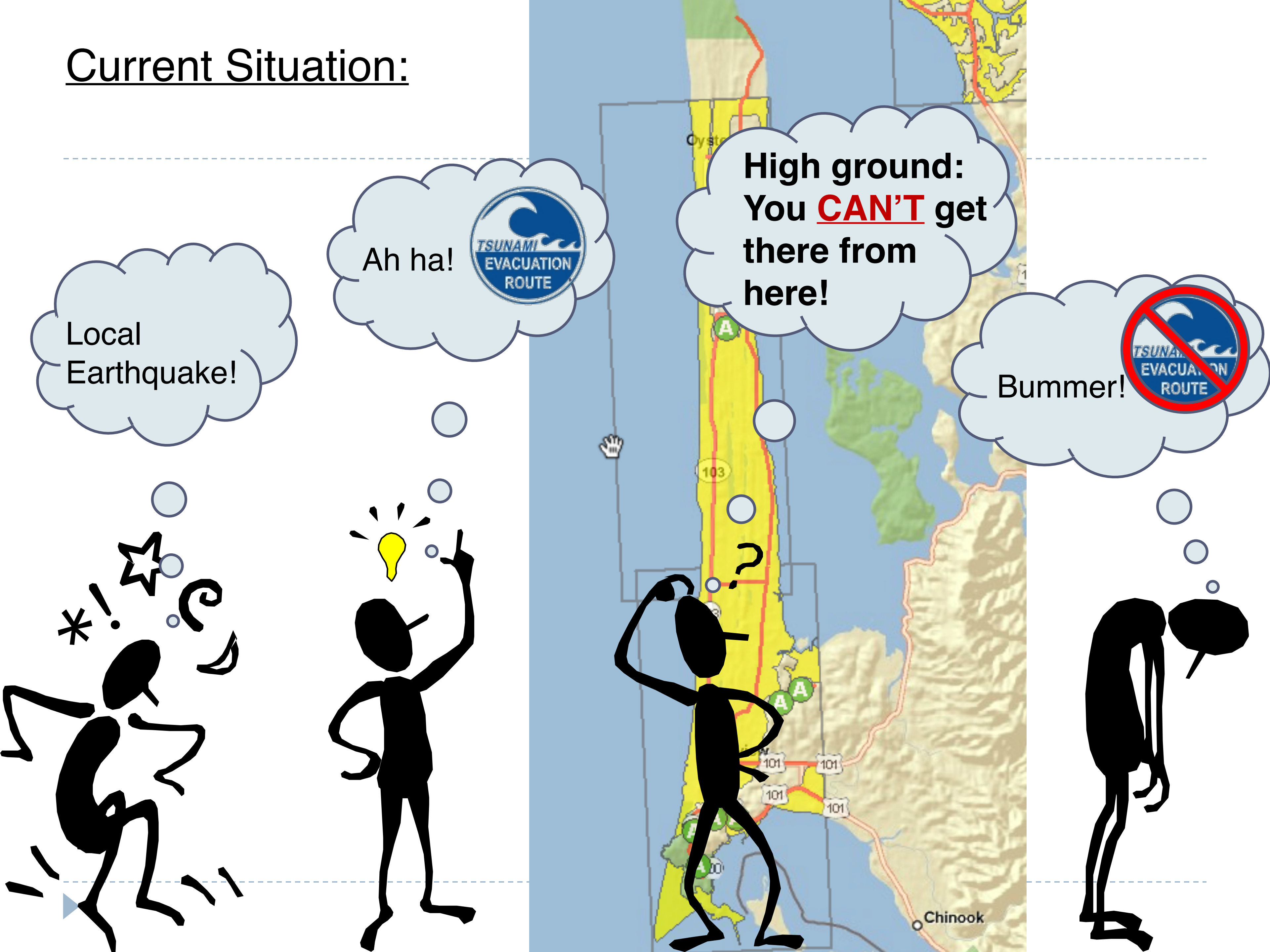
Run to High Ground when Possible – Use Vertical Evacuation when Necessary!

Kesenumma, Japan

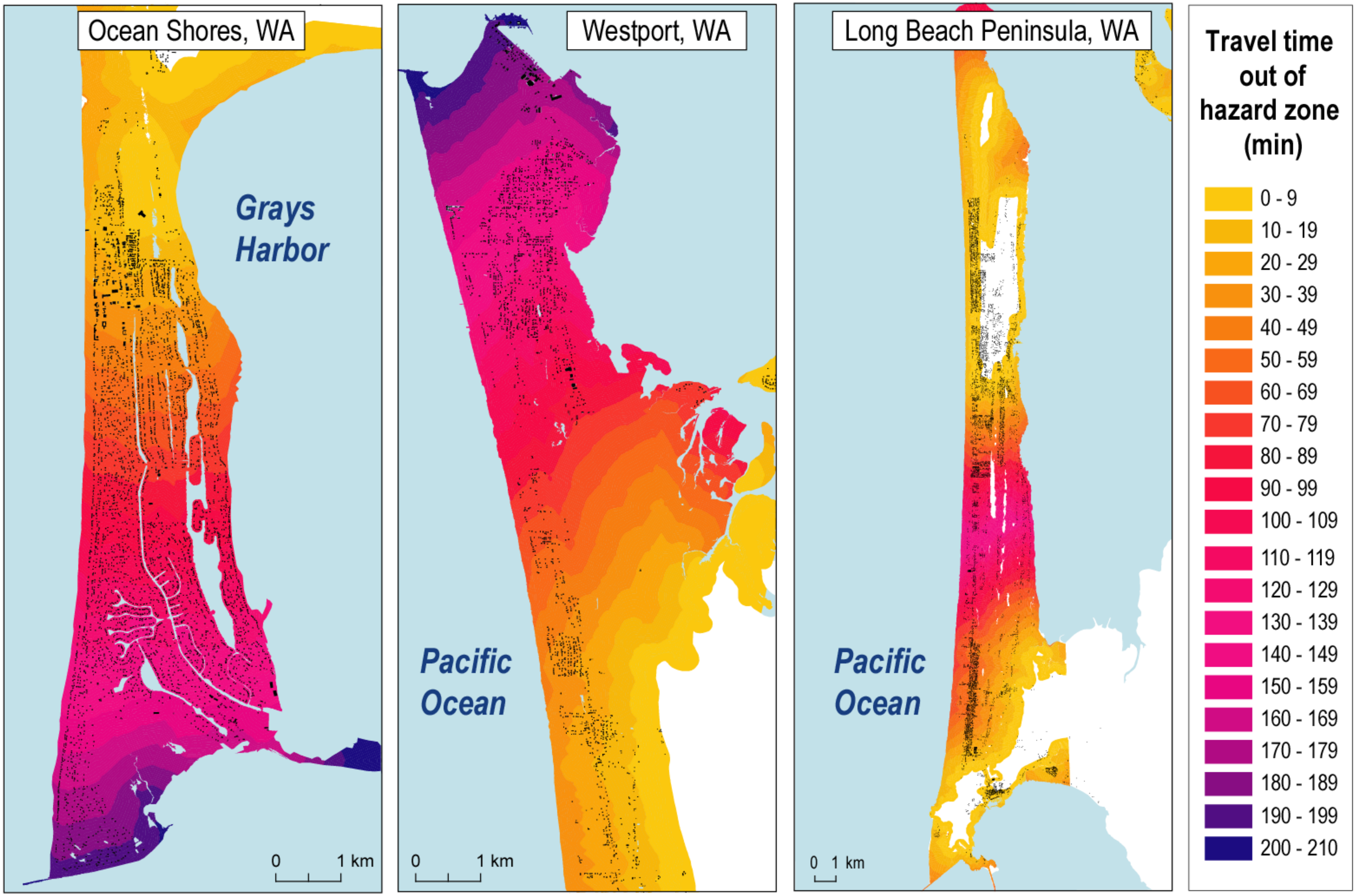


From Stuart Frasier, GNS Science

Current Situation:



Hotspots of Evacuation Challenges



Based on 1.1 m/s travel speed

Lesson #4

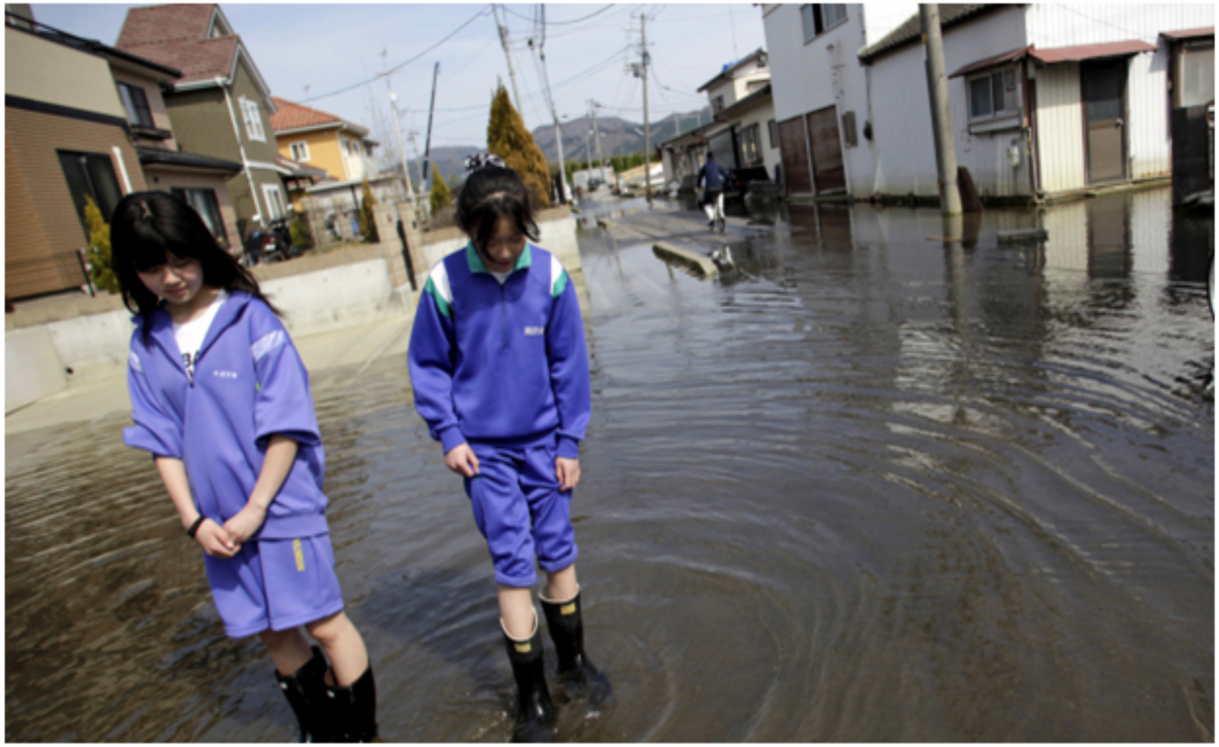
Expect the unexpected… Especially during recovery!

May 9, 2011 3:23 PM

PRINT TEXT ⊟ ⊞

Japanese towns flood daily after quake "sunk" land

6 Comments Have Your Say **Email Story** Send to a Friend **Share This** Tell Your Friends **Tweet This** Tweet This **More** Share It



Itsuki Mogi, 11, left, and and Umi Mogi, 12, watch the moving sea water in a street in front of their house in Ishinomaki, Miyagi Prefecture, Japan, May 3, 2011. (AP Photo/Junji Kurokawa)

Disaster In Japan

- Japan earthquake: before and after
- Search and Rescue in Japan
- Quake, tsunami slam Japan
- Lanterns fly in Japan to honor Tsunami victims
- Japan's tsunami: Six months later

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Lesson #5

We cannot rely on technology alone!

"The first tsunami warning issued by JMA at 14:49 LT for a *M7.9 quake* predicted inundation heights of 3 meters in Iwate and Fukushima and 6 meters in Miyagi. ***This was the only warning that local residents were able to receive due to the immediate destruction of the regional power supply system.***

JMA updated and revised the tsunami warning at 15:15 LT to 6 meters in Iwate and Fukushima and 10 meters in Miyagi. This warning was followed by an updated warning at 15:30 LT for a 10-meter tsunami for all areas.

However, these warnings never reached the majority of the local populace. Thus, some residents went to the nearest evacuation sites expecting a relatively small tsunami, while others thought the tsunami would cause only a small flood and took time to clear fallen debris before evacuating on foot or by car. In fact, the 10-to 20-meter- high tsunami struck most of the interview areas between about 15:25 and 15:35 LT."

Source: M. Ando, M. Ishida, Y. Nishikawa, C. Mizuki, and Y. Hayashi

“Public education without technological systems works great…

Technological systems without public education does not…

Best to have both…”

-Dr. Lori Dengler, Humboldt State University

Lesson #6

We must plan for the "The Post-Disaster Landscape"!

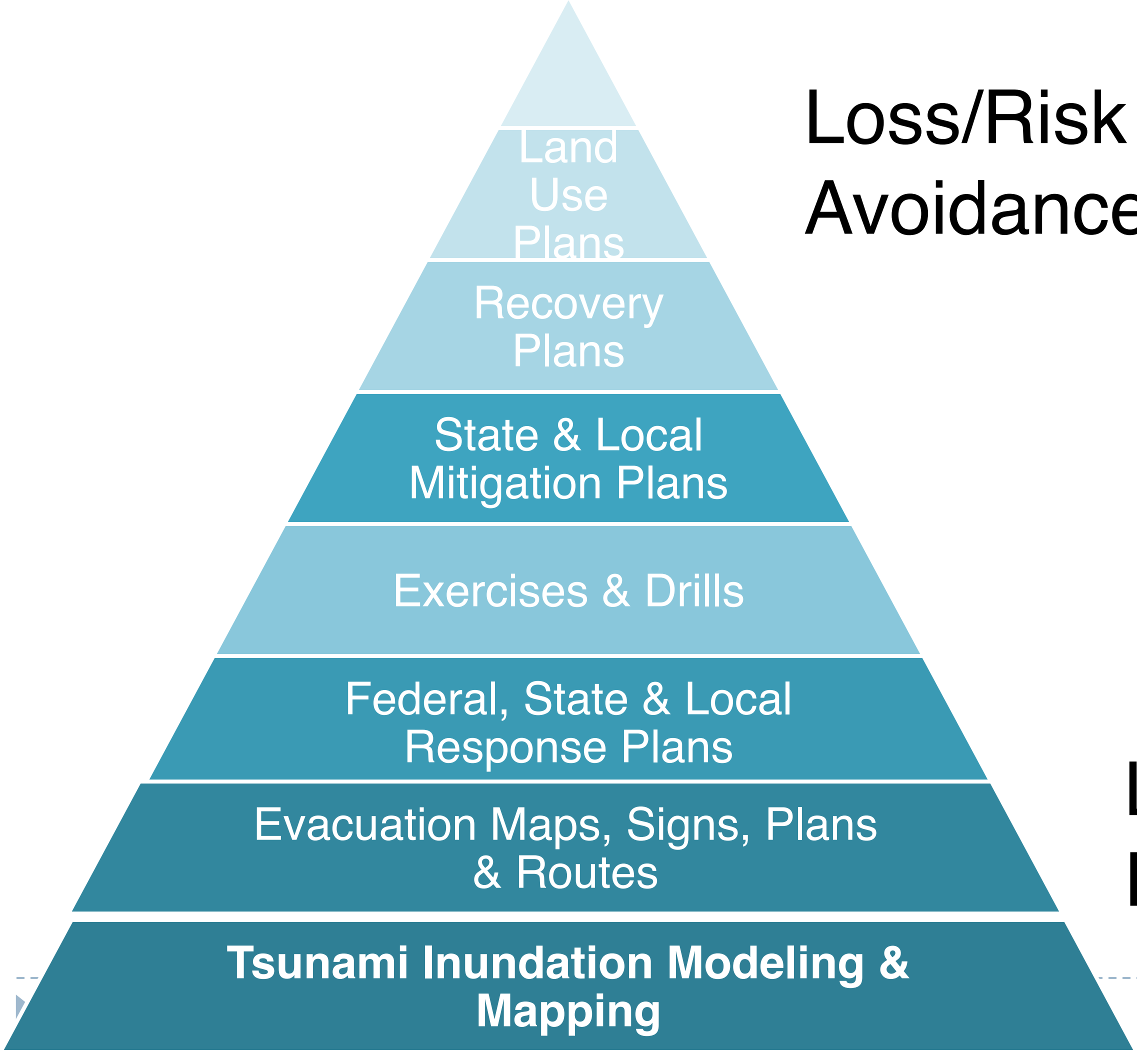
The Japanese authorities estimate a staggering 25 million tons of debris was generated in the three worst-affected prefectures. This is many times greater than the amount

earth

Much of the rubble and waste has been cleared from the streets, but the Japanese environment ministry last month revealed only 5% had been disposed of and 72% was still being stored at temporary sites.

- Once the debris is cleared…then what?

We MUST incorporate the Post-Disaster Landscape into our Pre-Event Land Use Planning



Land Use Plans

Recovery Plans

State & Local Mitigation Plans

Exercises & Drills

Federal, State & Local Response Plans

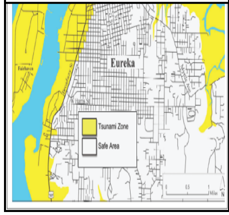
Evacuation Maps, Signs, Plans & Routes

Tsunami Inundation Modeling & Mapping

Loss/Risk Avoidance

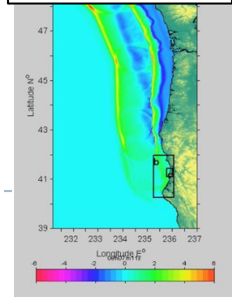
Loss/Risk Reduction

Evacuation Maps



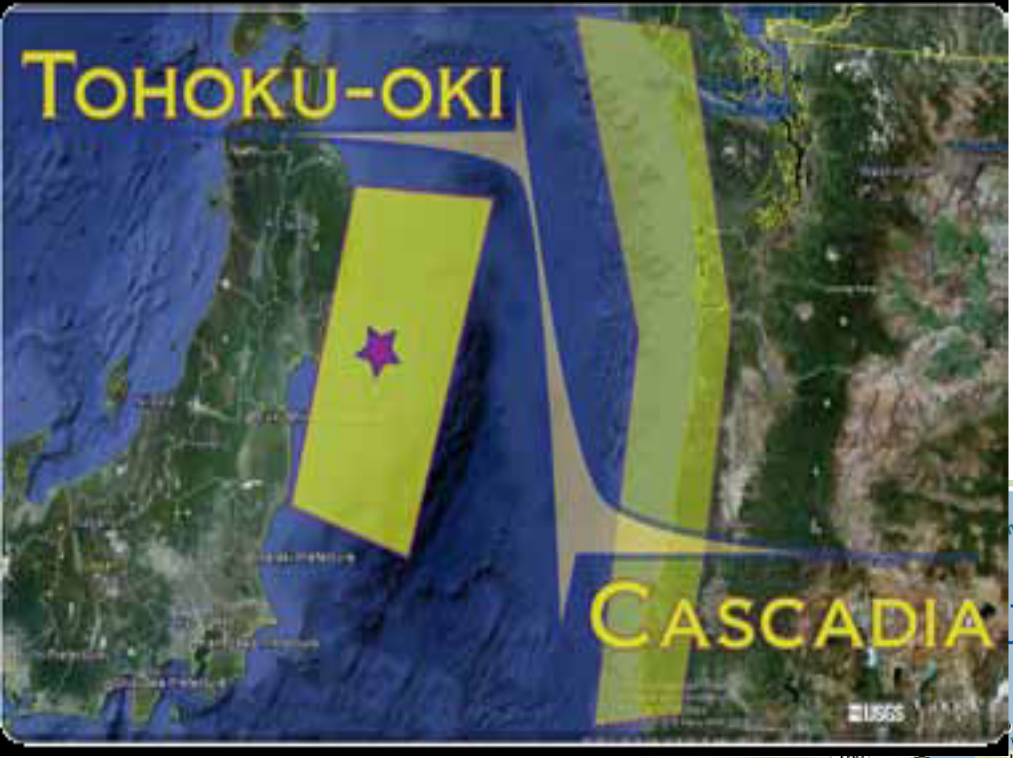
Inundation Maps

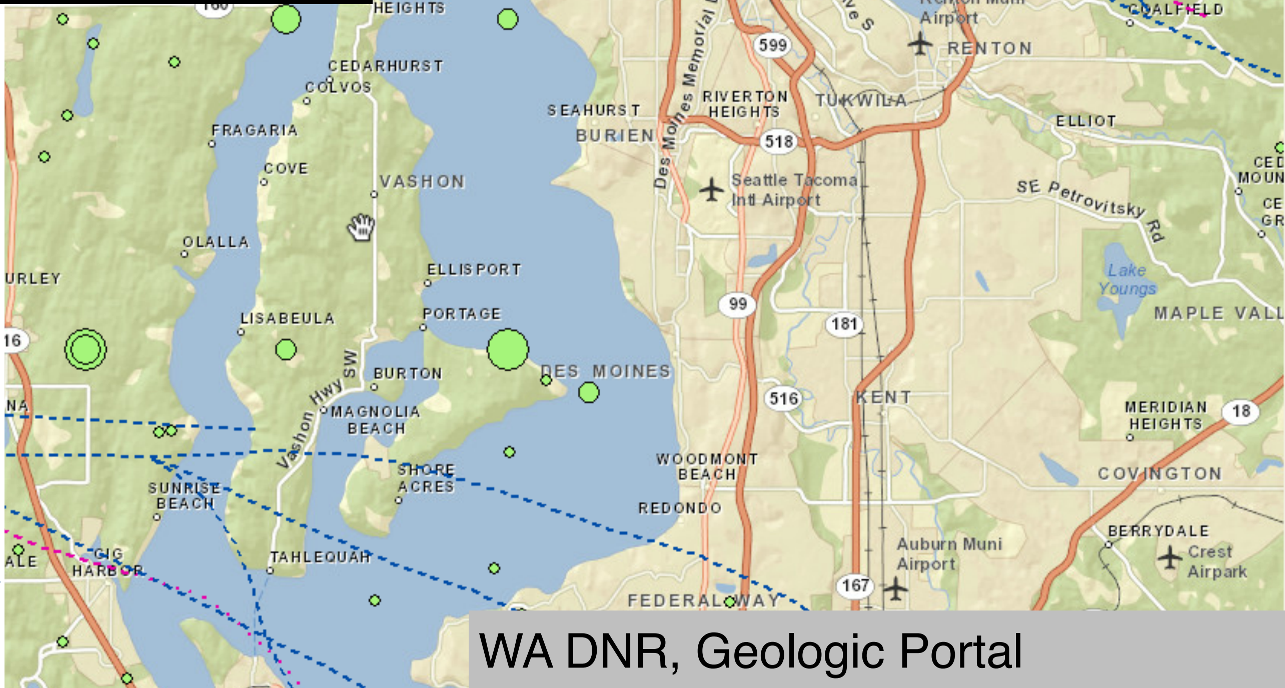
Modeling



Lesson #7
We MUST Start TODAY!

We all have our faults…





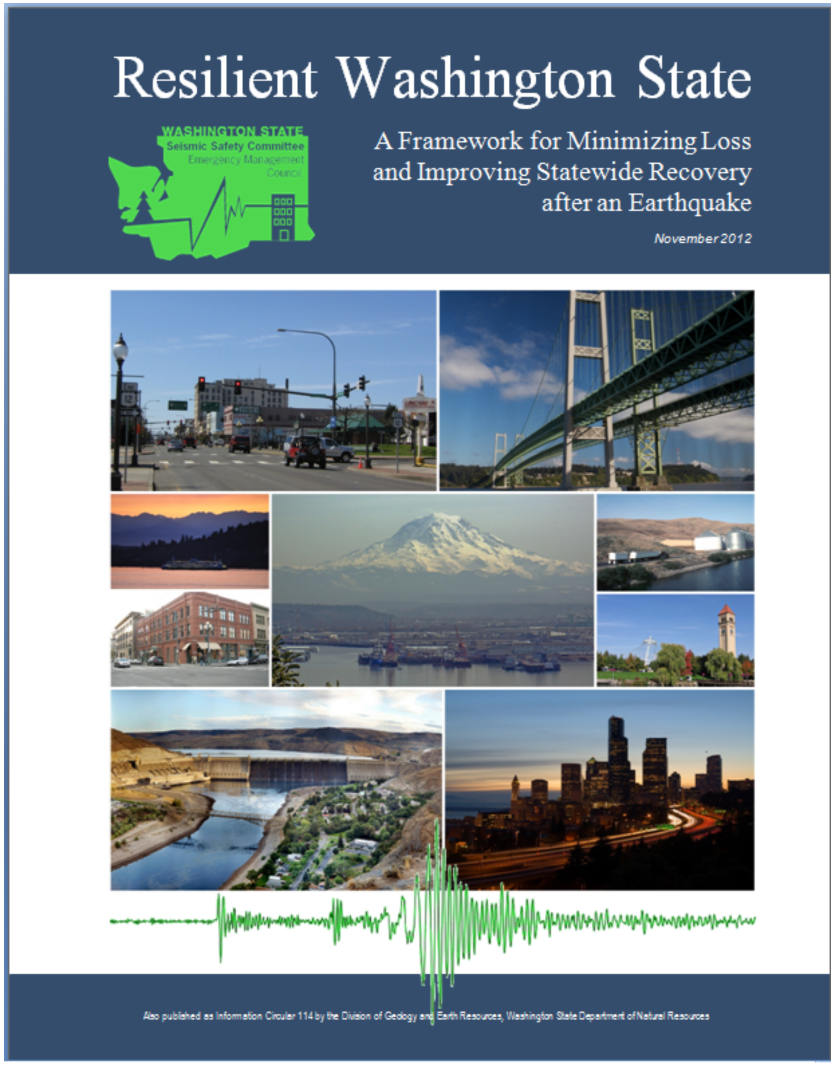
WA DNR, Geologic Portal

But we still have a long way to go! How do we get there from here?

(as quickly and inexpensively as possible…of course)

The Future…

The Resilient Washington State Initiative



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A Framework for Minimizing Loss
and Improving Statewide Recovery
after an Earthquake

November 2012

Also published as Information Circular 114 by the Division of Geology and Earth Resources, Washington State Department of Natural Resources

A New Framework & Approach for Improving Post-Earthquake Recovery

John Schelling
Geologic Hazards Program Manager, WA EMD
john.schelling@mil.wa.gov

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Seismic Safety Committee

James Mullen, *Washington State Emergency Management Division, Co-Chair*

Dave Norman,* *Washington State Department of Natural Resources, Co-Chair*

Stacy Bartoletti,* *Structural Engineers Association of Washington, RWS Chair*

Tamra Biasco,* *Federal Emergency Management Agency*

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Barbara Thurman, *Office of the Superintendant of Public Instruction*

John Vidale, *State Seismologist, University of Washington*

Tim Walsh,* *Washington State Department of Natural Resources*

Craig Weaver, *United States Geological Survey*

Writing & RWS Project support provided by Dr. Kyra L. Nourse.

**** DENOTES RWS SUBCOMMITTEE MEMBER***

Resilient Washington State

Process and Timing:

- 2008 – Seismic Safety Committee Revitalized
- 2009 – RWS Committee Formed
- 2010 – RWS Committee Developed Framework
- 9/17/2010 – Stakeholder Workshop 1 to form Sector Groups
- 12/2/2011 – Stakeholder Workshop 2 to learn about & deconflict Sector Group results/interdependencies
- 1-4/2012 – Review/Analyze Group Recommendations
- 6/30/2012 – Initial Draft Report Circulated
- 11/30/2012 – Final Draft Report Completed

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- Modeled after city level assessment completed by San Francisco Urban Planning & Research Association
- *Purpose & Timeframe*:
  - Provide a framework for improving Washington's resilience when earthquakes occur.
    - Framework includes more effective seismic mitigation policies and recommendations for legislation and policy changes to improve and enhance statewide seismic safety.
  - Goal of making the state resilient ***over the next 50 years.***
- WA SSC state-level model now being replicated in Oregon

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Resilient Washington State

Definition of a Resilient Washington State:

> *"A resilient state is one that maintains services and livelihoods after an earthquake. In the event that services and livelihoods are disrupted, recovery occurs rapidly, with minimal social disruption, and results in a new and better condition."*
>
> *- RWS Subcommittee*

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Life Safety and Human Health:

No life-threatening injuries from earthquake-induced damage or serious illness from lack of emergency medical care. Includes enforcing and updating building codes, eliminating non-structural hazards, and ensuring continuity of emergency health care.

Property Protection:

Public and private property built, retrofitted, or rebuilt to minimize earthquake-induced damage. Includes both structural and non-structura elements.

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Economic Security:

Access to income opportunities to meet basic needs before and soon after EQ. Includes employment, market access, distribution capacity, and supplier access.

Environmental Quality:

Natural resources and ecosystems should be managed to minimize earthquake-induced damage. Includes growth management, accident response capacity, and indus safety.

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Community Continuity:

Communities should have capacity to maintain social networks and livelihoods after an earthquake. Includes prevention of social-network disruption, social discrimination, and community bias.

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Four Sector Groups:

Critical Services	Utilities	Transportation	Housing & Economic Development
• Law enforcement • Emergency response • Health & medical care • Education • Mass care • Social Services • Food network • Government administration	• Domestic water supply • Wastewater systems • Flood control • Electricity • Natural Gas • Petroleum • Information & communication technology	• Interstate 5 • Interstate 90 • Interstate 405 • Ferry operations • Floating bridges • Major & minor arterials • Airports • Ports & navigable waterways • Rail • Mass transit	• Finance & banking • Commerce (commercial facilities) • Real estate & construction • Manufacturing (industrial facilities) • Planning & community development • Unreinforced masonry structures • Housing

Figure 1. The four sector groups and their components. Each sector group was chaired by one member of the Resilient Washington State Subcommittee and one volunteer from within the sector.

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Objectives for the Sector Groups:

- Evaluate the current condition Sector and assess how quickly they can be restored.
- Develop targets for the desired restoration time frame.
- Define the vulnerabilities and key interdependencies.
- Prepare recommendations for statewide action to achieve desired targets.

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Earthquake Hazard:

- Not possible to define single EQ scenario at a State level.
- Identified a suite of scenarios from the 20 scenario earthquakes developed in 2009 by personnel from the WA EMD, WA DNR, USGS, and FEMA for use in planning efforts.

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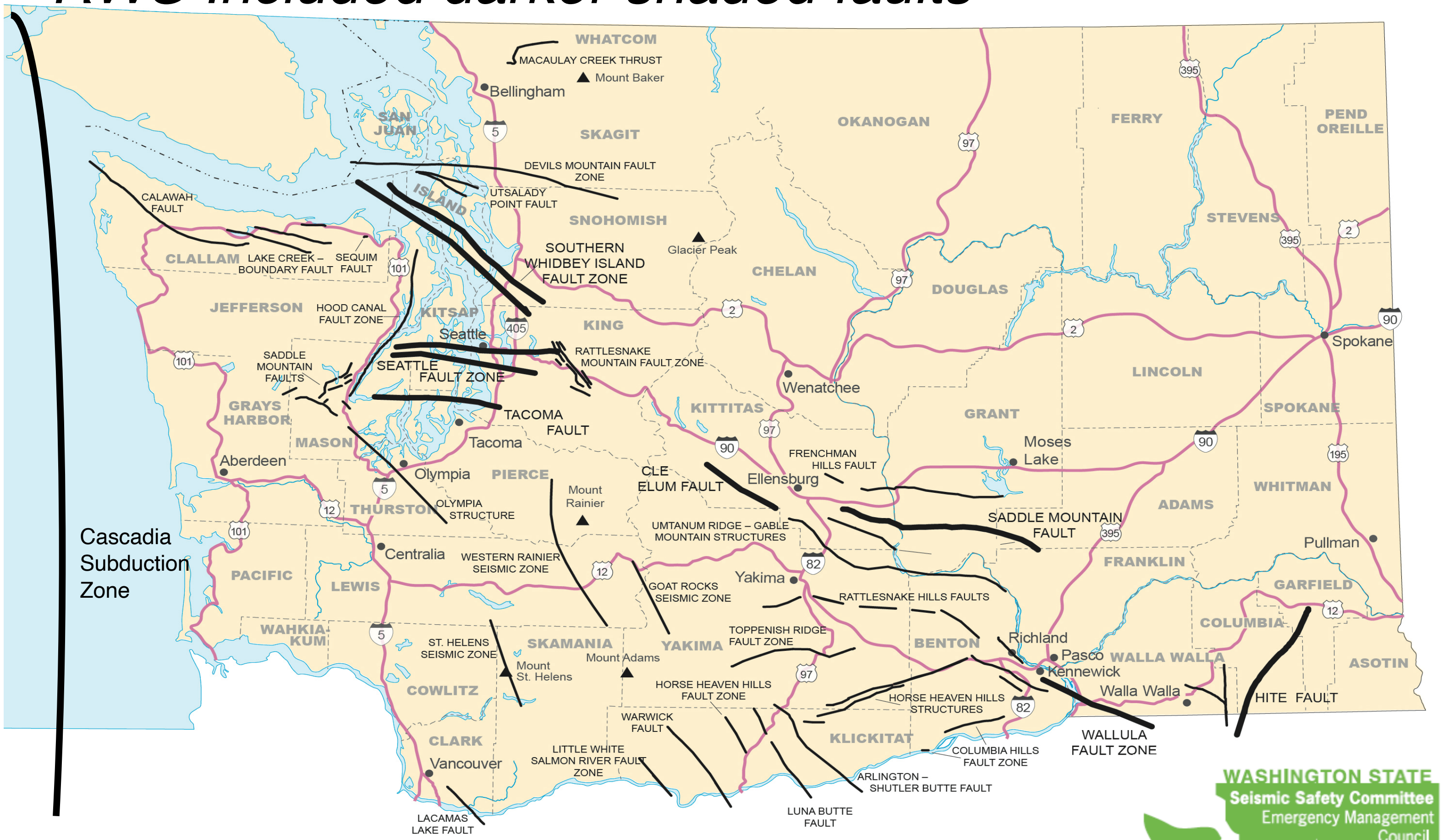
Earthquake Faults in Washington State:

RWS Included darker shaded faults



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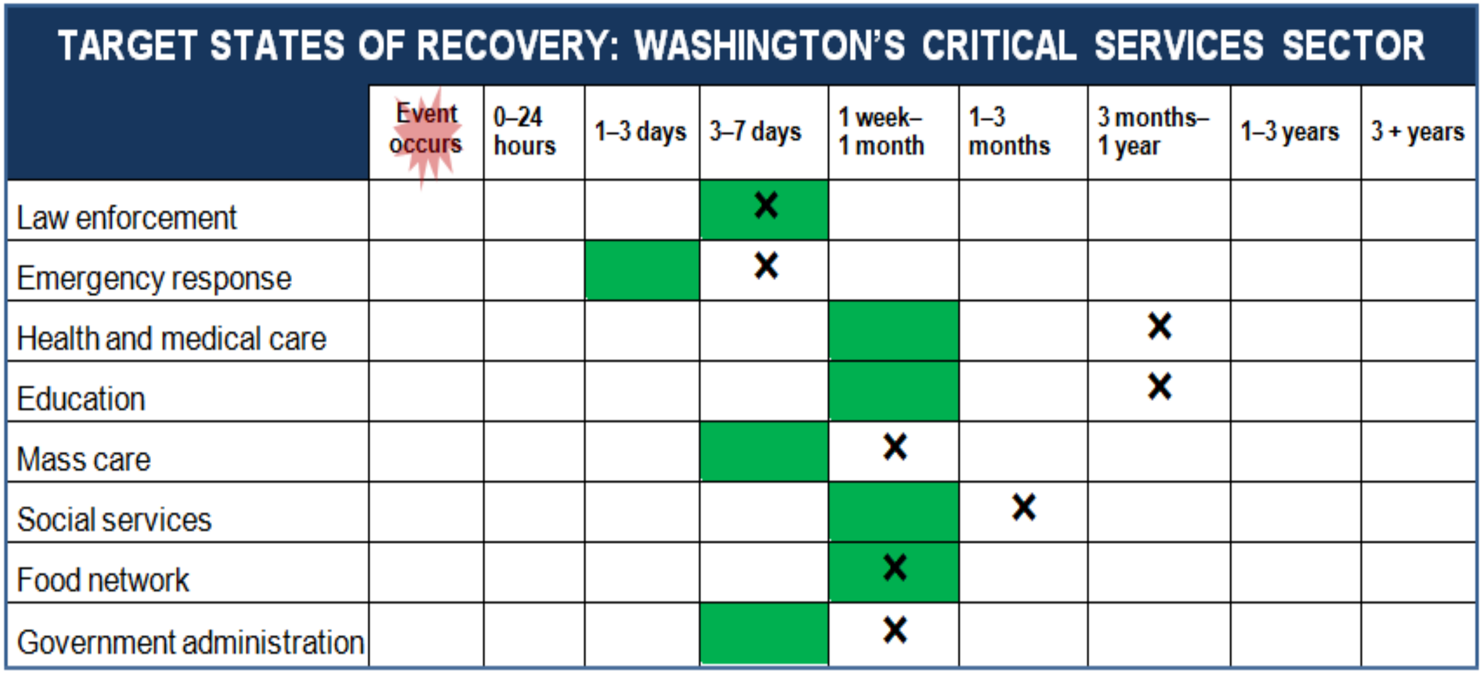
Critical Services



TARGET STATES OF RECOVERY: WASHINGTON'S CRITICAL SERVICES SECTOR

	Event occurs	0–24 hours	1–3 days	3–7 days	1 week–1 month	1–3 months	3 months–1 year	1–3 years	3 + years
Law enforcement				🟩 X					
Emergency response			🟩	X					
Health and medical care					🟩		X		
Education					🟩		X		
Mass care				🟩	X				
Social services					🟩	X			
Food network					🟩 X				
Government administration				🟩	X				

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Utilities

TARGET STATES OF RECOVERY: WASHINGTON'S UTILITIES SECTOR

	Event occurs	0–24 hours	1–3 days	3–7 days	1 week–1 month	1–3 months	3 months–1 year	1–3 years	3+ years
Domestic water supply									
Supply & transmission pipes			🟩	NL			L		
Distribution pipes			🟩		NL		L		
Wastewater systems									
Treatment facilities					🟩	NL	L		
Sewer pipes					🟩	NL		L	
Flood control									
Dams					🟩	×			
Levees					🟩			×	
Electricity									
Transmission					🟩			×	
Distribution, 60% restored					🟩 ×				
Distribution, 70% restored					🟩	×			
Distribution, >70% restored					🟩		×		
Natural Gas									
Transmission			🟩 NL		L				
Distribution, 40% restored					🟩 ×				
Distribution, 90% restored					🟩	×			
Petroleum									
Refineries & transmission					🟩			×	
Distribution				🟩		×			
Information and communication technology				🟩		×			

KEY TO THE TABLE

TARGET TIMEFRAME FOR RECOVERY:

Operational (time it ought to take to restore component to 80–90% operational):	🟩
TIME NEEDED FOR RECOVERY TO 80–90% OPERATIONAL GIVEN CURRENT CONDITIONS:	×
TIME NEEDED FOR RECOVERY TO 80–90% OPERATIONAL IN LIQUEFACTION ZONES GIVEN CURRENT CONDITIONS:	L
TIME NEEDED FOR RECOVERY TO 80–90% OPERATIONAL IN NON-LIQUEFACTION ZONES GIVEN CURRENT CONDITIONS:	NL

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Transportation

TARGET STATES OF RECOVERY: WASHINGTON'S TRANSPORTATION SECTOR

	Event occurs	0–24 hours	1–3 days	3–7 days	1 week–1 month	1–3 months	3 months–1 year	1–3 years	3+ years
Interstate 5									
Puget Sound (center & north)				🟥	🟨	🟩		×	
South end (Chehalis south)			🟥	🟨	🟩		×		
Interstate 90									
Puget Sound (Snoqualmie Pass west)				🟥	🟨	🟩		×	
Cascades to eastern WA (Snoqualmie to Idaho)			🟥	🟨	🟩		×		
Interstate 405									
South end (Tukwila to I-90)			🟥	🟨		🟩		×	
North end (I-90 to Lynnwood)				🟥	🟨	🟩		×	
Ferry operations		🟥		🟨	🟩		×		
Floating Bridges									
SR 520				🟥	🟨	🟩		×	
I-90			🟥	🟨	🟩		×		
Hood Canal		🟥	🟨	🟩	×				

KEY TO THE TABLE

TARGETS TO ACHIEVE DIFFERENT LEVELS OF RECOVERY:

Minimal *(A minimum level of service is restored, primarily for the use of emergency responders, repair crews, and vehicles transporting food and other critical supplies.)*	🟥
Functional *(Service is not yet restored to full capacity, but is sufficient to get the economy moving again—e.g. some truck/freight traffic can be accommodated. There may be fewer lanes in use, some weight restrictions, and lower speed limits.)*	🟨
Operational *(Restoration is up to 80–90% of capacity: A full level of service has been restored and is sufficient to allow people to commute to school and to work.)*	🟩
TIME NEEDED FOR RECOVERY TO 80–90% OPERATIONAL GIVEN CURRENT CONDITIONS:	×

For a number of components, the timeframes marked in the table reflect the estimated recovery period following a worst case scenario earthquake. See the notes in Workshop Report II for details.

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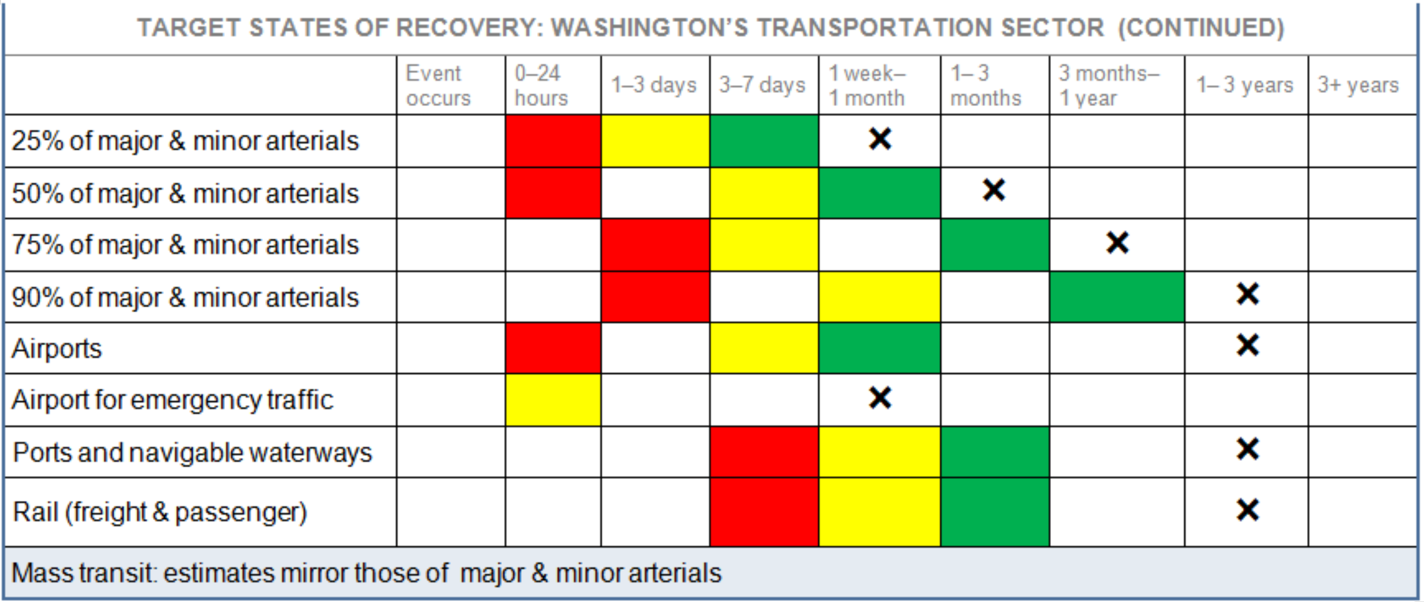
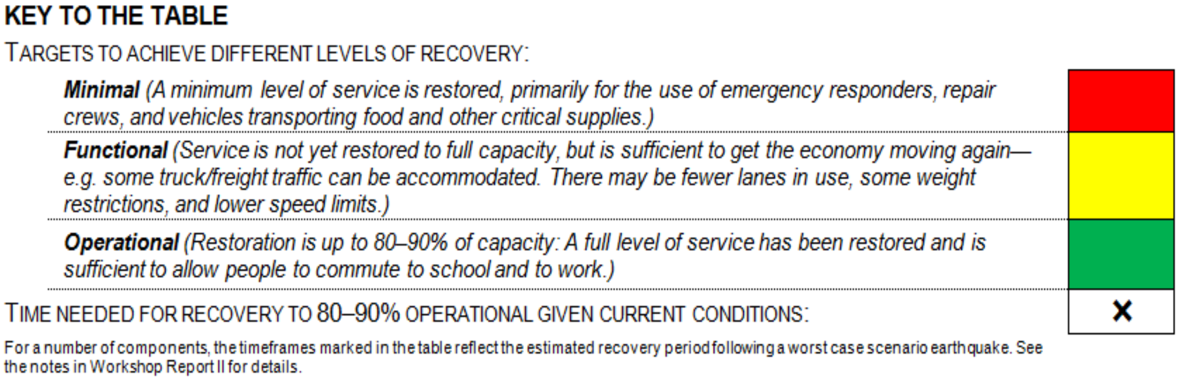
nsportation (cont.)



TARGET STATES OF RECOVERY: WASHINGTON'S TRANSPORTATION SECTOR (CONTINUED)	Event occurs	0–24 hours	1–3 days	3–7 days	1 week–1 month	1– 3 months	3 months–1 year	1– 3 years	3+ years
25% of major & minor arterials		🟥	🟨	🟩	✕				
50% of major & minor arterials		🟥		🟨	🟩	✕			
75% of major & minor arterials			🟥	🟨		🟩	✕		
90% of major & minor arterials			🟥		🟨		🟩	✕	
Airports		🟥		🟨	🟩			✕	
Airport for emergency traffic		🟨			✕				
Ports and navigable waterways				🟥	🟨	🟩		✕	
Rail (freight & passenger)				🟥	🟨	🟩		✕	
Mass transit: estimates mirror those of major & minor arterials									



KEY TO THE TABLE

TARGETS TO ACHIEVE DIFFERENT LEVELS OF RECOVERY:

Minimal *(A minimum level of service is restored, primarily for the use of emergency responders, repair crews, and vehicles transporting food and other critical supplies.)*	🟥
Functional *(Service is not yet restored to full capacity, but is sufficient to get the economy moving again—e.g. some truck/freight traffic can be accommodated. There may be fewer lanes in use, some weight restrictions, and lower speed limits.)*	🟨
Operational *(Restoration is up to 80–90% of capacity: A full level of service has been restored and is sufficient to allow people to commute to school and to work.)*	🟩
TIME NEEDED FOR RECOVERY TO 80–90% OPERATIONAL GIVEN CURRENT CONDITIONS:	✕

For a number of components, the timeframes marked in the table reflect the estimated recovery period following a worst case scenario earthquake. See the notes in Workshop Report II for details.

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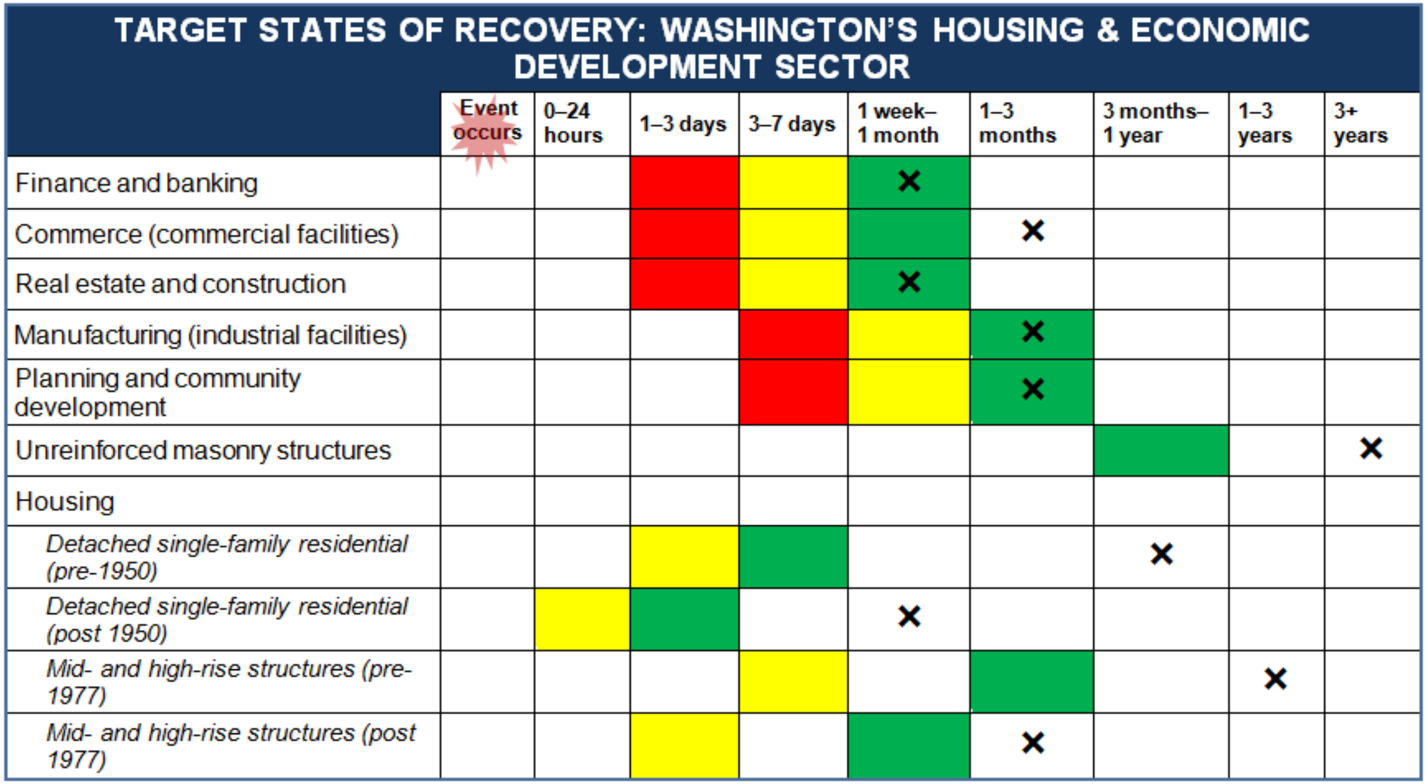
Housing & Economic Development



TARGET STATES OF RECOVERY: WASHINGTON'S HOUSING & ECONOMIC DEVELOPMENT SECTOR

	Event occurs	0–24 hours	1–3 days	3–7 days	1 week–1 month	1–3 months	3 months–1 year	1–3 years	3+ years
Finance and banking			🟥	🟨	🟩 ×				
Commerce (commercial facilities)			🟥	🟨	🟩	×			
Real estate and construction			🟥	🟨	🟩 ×				
Manufacturing (industrial facilities)				🟥	🟨	🟩 ×			
Planning and community development				🟥	🟨	🟩 ×			
Unreinforced masonry structures							🟩		×
Housing									
Detached single-family residential (pre-1950)			🟨	🟩			×		
Detached single-family residential (post 1950)		🟨	🟩		×				
Mid- and high-rise structures (pre-1977)				🟨		🟩		×	
Mid- and high-rise structures (post 1977)			🟨		🟩	×			

KEY TO THE TABLE

TARGETS TO ACHIEVE DIFFERENT LEVELS OF RECOVERY:

Minimal:	🟥
Functional:	🟨
Operational (time it ought to take to restore component to 80–90% operational):*	🟩
TIME NEEDED FOR RECOVERY TO 80–90% OPERATIONAL GIVEN CURRENT CONDITIONS:	×

For a number of components, the timeframes marked in the table reflect the estimated recovery period following a worst case scenario earthquake.

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Resilience Recommendations

Recommendations are predicated upon the following:

1. Mitigation activities should be incentivized to the greatest degree possible – buying down tomorrow's risk at today's rates
2. Use earthquake & tsunami mitigation activities to:
    - create jobs;
    - stimulate economy;
    - reduce unemployment; and
    - reduce risk to people, property, the economy, and the environment
3. Leverage potential private sector investments to off set costs to state and citizens.

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Ten Resilience Recommendations:

1. Make schools resilient: structurally, socially, and educationally.
2. Require that utility providers identify the vulnerabilities in their systems and mitigate the deficiencies.
3. Improve the resilience of buildings in areas of high seismic hazard to improve life safety and increase the number of people who will be able to shelter in place.
4. Assess the permitting requirements that relate to environmental protection and mitigation to determine how best to make environmental planning mesh with seismic mitigation and recovery planning.

Ten Resilience Recommendations:

6. Strengthen regional transportation networks.

7. Make hospitals resilient—structurally and functionally.

8. Identify and map in greater detail sources of seismicity and geologically hazardous areas and develop plans for mitigation of identified hazards.

9. Improve life safety in coastal communities at risk of local tsunamis.

10. Implement resilience principles through formalized accountability.

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Potential EMC Actions/ Opportunities

1. Establish a state lifelines subcommittee or working group to facilitate improved coordination, planning, and response among lifeline operators

2. Assist with facilitation between public and private sector organizations to enhance business continuity planning efforts.

3. Monitor and report on implementation of resilience principles.

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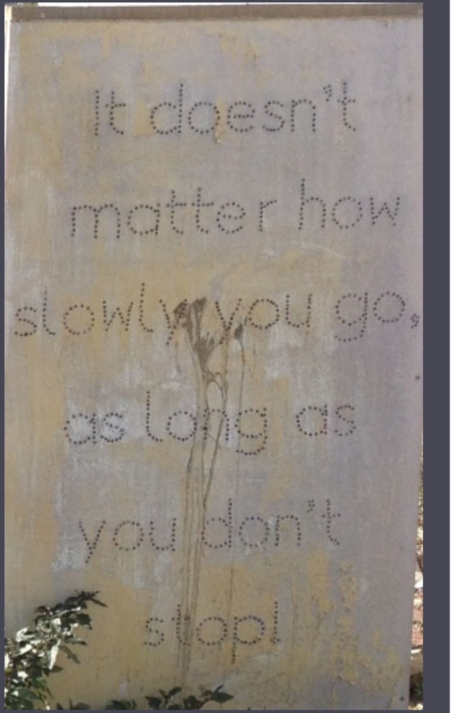
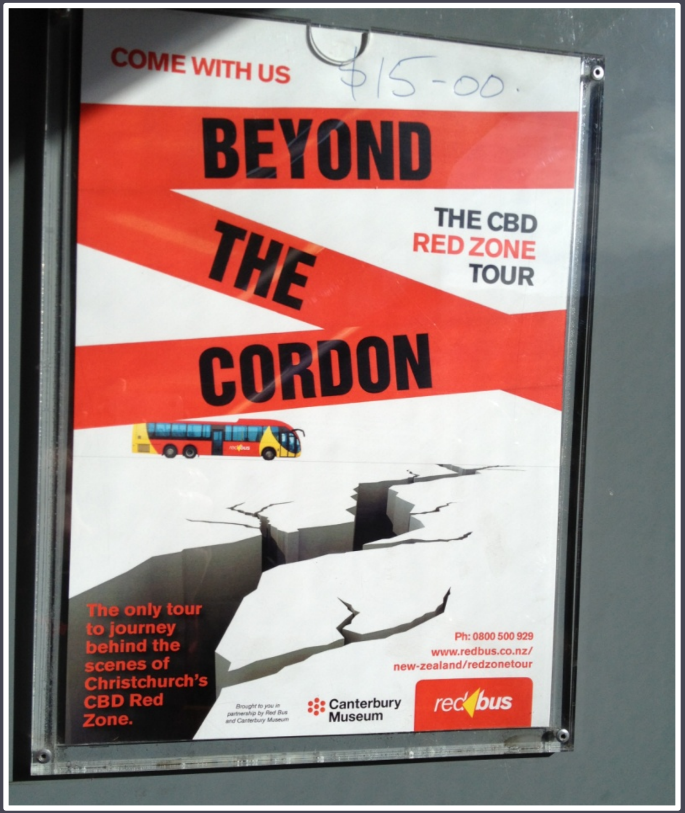
With every disaster comes opportunity.

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